

Tab. 1 Efficiency comparison between OTSU and ILTD\_ABC

		a		b		c		d	
		OTSU	ILTD_ABC	OTSU	ILTD_ABC	OTSU	ILTD_ABC	OTSU	ILTD_ABC
$M-1=1$	fitness	5693.46	5693.46	4945.70	4945.70	5659.89	5659.89	3684.98	3684.98
	threshold	155	155	152	152	158	158	134	134
	time (s)	<b>0.34</b>	<u>2.59</u>	<b>0.20</b>	<u>2.48</u>	<b>1.51</b>	<u>2.51</u>	<b>0.50</b>	<u>2.35</u>
$M-1=2$	fitness	8860.59	8860.59	7615.14	7615.14	9042.81	9042.81	5449.09	5449.09
	threshold	130,162	130,162	123,161	123,161	131,171	131,171	102,146	102,146
	time (s)	43.98	<b>2.60</b>	47.23	<b>2.51</b>	46.70	<b>2.62</b>	53.04	<b>2.34</b>
$M-1=3$	fitness	10726.61	10726.61	9089.33	9089.33	11051.06	11051.06	6426.09	6426.09
	threshold	118,149,176	118,149,176	101,147,169	101,147,169	120,149,177	120,149,177	86,129,155	86,129,155
	time (s)	8261.49	<b>5.14</b>	7094.32	<b>5.04</b>	8525.87	<b>5.00</b>	7572.68	<b>4.75</b>

		e		f		g		h	
		OTSU	ILTD_ABC	OTSU	ILTD_ABC	OTSU	ILTD_ABC	OTSU	ILTD_ABC
$M-1=1$	fitness	2473.96	2473.96	7163.92	7163.92	4821.13	4821.13	10601.25	10601.25
	threshold	99.00	99.00	169.00	169.00	141.00	141.00	243.00	243.00
	time (s)	<b>0.29</b>	<u>3.10</u>	<b>0.09</b>	<u>2.52</u>	<b>0.09</b>	<u>2.12</u>	<b>0.10</b>	<u>2.11</u>
$M-1=2$	fitness	4028.27	4028.27	11822.50	11822.50	7869.53	7869.53	17188.09	17188.09
	threshold	91, 102	91, 102	159, 174	159, 174	126, 150	126, 150	200, 252	200, 252
	time (s)	<b>2.42</b>	<u>3.32</u>	5.32	<b>2.68</b>	13.14	<b>2.36</b>	18.07	<b>2.14</b>
$M-1=3$	fitness	4845.20	4845.20	14382.36	14382.36	9651.81	9651.81	21054.90	21054.90
	threshold	86, 96, 103	86, 96, 103	143, 167, 178	143, 167, 178	117, 136, 154	117, 136, 154	166, 234, 255	166, 234, 255
	time (s)	553.76	<b>3.33</b>	2473.89	<b>2.80</b>	5302.86	<b>2.50</b>	7457.25	<b>2.32</b>

Tab. 2 Segmentation accuracy comparison among algorithms which are designed specifically for image segmentation problem

	a			b			c			d		
	4	5	6	5	6	7	4	5	6	4	5	6
PSO	9334.51	9931.36	10297.63	7167.71	7431.76	7621.87	5687.32	5946.74	6142.66	10817.55	11422.29	11855.99
	11.86	33.49	52.51	15.77	33.55	40.82	5.18	9.08	13.21	2.29	12.96	35.7
QPSO	9342.57	9965.36	10368.47	7187.87	7479.82	7686.76	5692.16	5957.78	6155.86	10818.87	11429.78	11872.34
	2.05	15.25	11.53	5.76	9.74	19.07	0.76	4.96	8.96	3.03	5.66	24.84
CQPSO	9340.12	9971.89	10374.3	7186.53	7485.36	7695.31	5690.49	5957.55	6159.79	10819.6	11431.84	<b>11900.74</b>
	3.1	3.61	13.13	3.68	8.95	10.3	2.36	4.54	4.68	1.72	6.77	<b>25.94</b>
MPSO	8665.85	8979.48	9246.93	6590.02	6755.81	6938	5513.35	5686.12	5803.32	10664.22	11140.23	11561.05
	325.25	356.92	277.23	199.08	191.03	175.37	108.72	119.83	115.41	72.22	101.41	92.93
DE	9332.16	9934.65	10315.18	7165.99	7447.18	7651.44	5682.4	5945.02	6135.57	10804.65	11401.54	11842.96
	8.07	20.3	26.25	13.25	12.56	16.49	4.5	8.2	8.62	8.09	12.72	26
MRLDE	9337.99	9944.75	10330.61	7168.28	7454.94	7651.61	5686.91	5947.19	6142.93	10810.96	11407.38	11838.01
	4.78	15.54	20.31	8.25	13.94	18.5	3.6	6.84	7.42	5.11	9.2	20.31
SDE	9333.68	9936.41	10321.22	7164.57	7454.51	7644.73	5684.33	5941.49	6139.33	10806.69	11398.09	11839.24
	7.3	17.88	23.29	11.97	16.84	17.59	3.56	8.51	11.4	4.99	14.32	15.11
ABC	9342.02	9968.37	10368.25	7182.87	7481.11	7684.36	5690.49	5956.04	6156.6	10816.58	11425.95	11885.48
	2.71	4.89	7.91	4.13	6.21	8.53	2.01	3.64	3.44	2.63	4.77	18.93
MABC15	8719.43	9637.98	10022.63	6945.38	6981.75	7177.54	5690.53	5361.43	5746.95	10816.9	11428.06	11890.51
	2330.37	1789.73	1861.22	1289.73	1865.96	1918.29	2.11	1787.14	1535.94	2.4	4.82	21.27
I_ABC	9334.21	9949.29	10333.47	7176.43	7466.52	7413.98	5686.66	5948.31	6150.73	10809.37	11413.66	11853.65

	6.03	14.98	25.08	8.55	13.87	1376.83	2.81	6.28	5.83	4.68	10.14	18.42
ILTD	<b>9344.2</b>	<b>9973.14</b>	<b>10378.7</b>	<b>7188.16</b>	<b>7486.19</b>	<b>7697.53</b>	<b>5692.41</b>	<b>5961.42</b>	<b>6160.77</b>	<b>10820.42</b>	<b>11432.51</b>	11891.11
_ABC	<b>0.15</b>	<b>1.09</b>	<b>7.85</b>	<b>2.71</b>	<b>6.01</b>	<b>7.75</b>	<b>0.04</b>	<b>1.77</b>	<b>4.69</b>	<b>1.2</b>	<b>2.97</b>	22.72

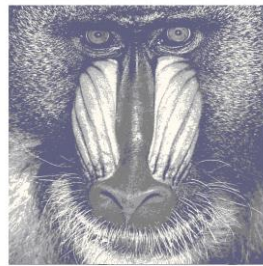
	e			f			g			h		
	4	5	6	5	6	7	4	5	6	4	5	6
PSO	5292.15 6.95	5543.24 15.60	5651.97 58.89	15895.47 14.40	16736.79 233.59	17244.10 173.97	10728.62 17.19	11389.45 40.99	11759.68 92.71	23260.43 0.17	24547.01 1.76	25371.72 10.60
QPSO	5294.41 3.62	5547.50 15.97	5697.39 15.55	15903.51 5.14	16812.53 23.51	17383.57 52.36	10739.27 3.32	11433.64 21.02	11888.02 18.20	23258.69 6.29	24540.11 5.59	25358.21 22.96
CQPSO	<b>5295.60</b> 0.00	5548.71 16.72	5704.48 16.59	15903.36 5.17	16821.96 27.75	17434.78 38.43	10735.95 3.55	11450.34 10.62	<b>11900.42</b> <b>7.52</b>	23239.00 40.37	24502.68 96.56	25328.09 111.95
MPSO	5058.98 137.85	5188.65 284.87	5183.65 257.21	15035.72 487.72	15439.88 819.38	15860.55 584.74	9900.97 438.89	10318.80 347.20	10523.17 337.66	23148.18 71.25	24303.41 122.54	25014.48 206.98
DE	5294.77 1.03	5549.81 10.58	5694.87 13.41	15895.18 8.61	16786.55 26.66	17369.27 38.63	10720.90 9.77	11403.74 22.62	11839.66 27.32	23219.86 37.36	24426.38 64.31	25201.98 61.90
MRLDE	5295.33 0.64	5552.03 8.11	5693.63 12.47	15898.14 9.30	16801.29 24.80	17375.24 40.97	10729.71 7.19	11418.42 19.97	11845.90 30.38	23238.55 14.80	24498.57 39.87	25286.43 45.45
SDE	5294.81 0.90	5548.02 8.75	5693.40 10.37	15886.42 16.00	16791.44 27.43	17366.99 25.74	10726.36 7.01	11406.29 32.39	11826.76 30.15	23223.94 20.54	24457.90 63.74	25255.86 59.77
ABC	5295.52 0.33	5558.71 3.57	5704.72 9.17	15903.13 5.11	16817.64 20.27	17422.42 27.71	10735.14 4.63	11442.40 12.72	11882.72 15.72	23252.80 7.09	24534.88 7.41	25347.13 21.82
MABC15	5295.60 0.00	5560.51 3.56	5429.20 1245.56	15904.62 2.25	15990.09 3668.39	14823.00 6226.93	10739.11 2.84	10875.84 2495.11	11296.73 2591.67	23259.95 0.62	24538.74 6.20	25356.10 18.34
I_ABC	5290.14 10.38	5545.78 15.45	5690.53 15.40	15883.23 24.10	16760.10 64.79	17330.51 98.71	10722.41 11.73	11415.72 23.15	11841.23 29.90	23241.14 13.76	24505.09 32.90	25269.05 71.73
ILTD _ABC	<b>5295.60</b> <b>0.00</b>	<b>5562.28</b> <b>1.21</b>	<b>5714.75</b> <b>8.98</b>	<b>15905.21</b> <b>0.00</b>	<b>16834.42</b> <b>6.69</b>	<b>17448.91</b> <b>22.21</b>	<b>10740.19</b> <b>0.78</b>	<b>11455.61</b> <b>3.45</b>	11899.84 7.04	<b>23260.26</b> <b>0.91</b>	<b>24545.09</b> <b>4.50</b>	<b>25374.24</b> <b>8.66</b>



(a) ABC



(b) ABC



(c) ABC



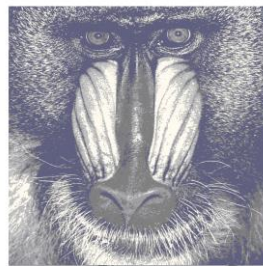
(d) ABC



(a') ILTD\_ABC



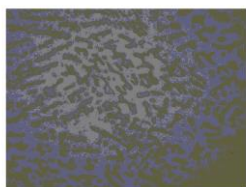
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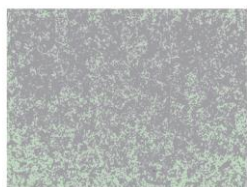
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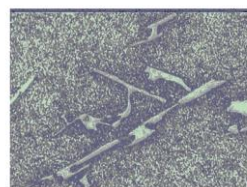
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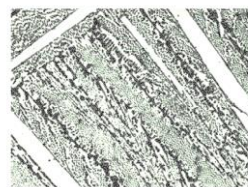
(e) ABC



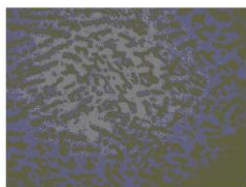
(f) ABC



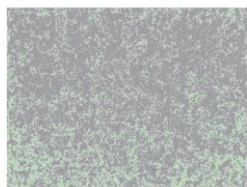
(g) ABC



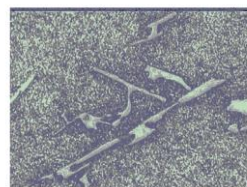
(h) ABC



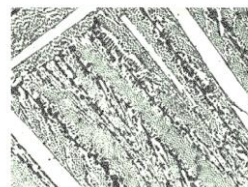
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(f') ILTD\_ABC

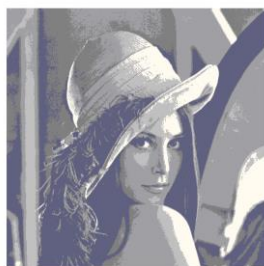


(g') ILTD\_ABC

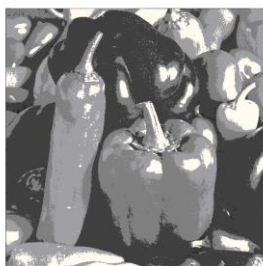


(h') ILTD\_ABC

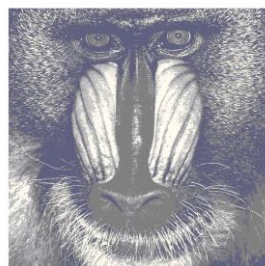
Fig. 1 Segmentation images,  $M - 1 = 4$



(a) ABC



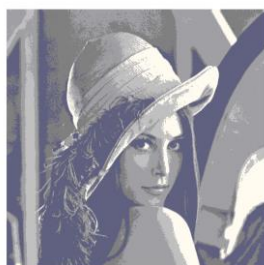
(b) ABC



(c) ABC



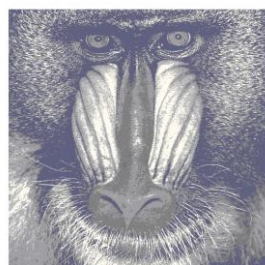
(d) ABC



(a') ILTD\_ABC



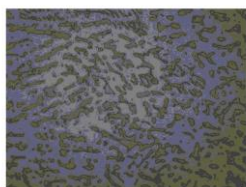
(b') ILTD\_ABC



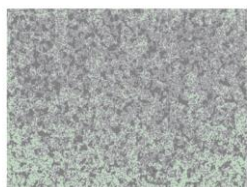
(c') ILTD\_ABC



(d') ILTD\_ABC



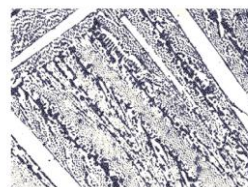
(e) ABC



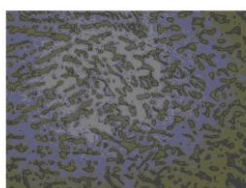
(f) ABC



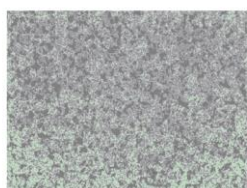
(g) ABC



(h) ABC



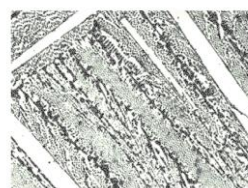
(e') ILTD\_ABC



(f') ILTD\_ABC



(g') ILTD\_ABC



(h') ILTD\_ABC

Fig. 2 Segmentation images,  $M - 1 = 5$

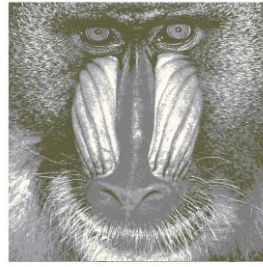




(a) ABC



(b) ABC



(c) ABC



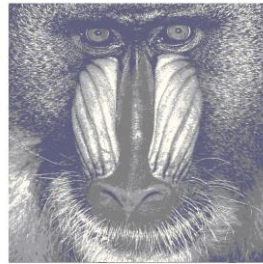
(d) ABC



(a') ILTD\_ABC



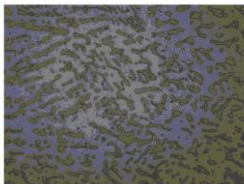
(b') ILTD\_ABC



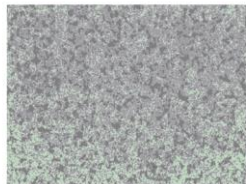
(c') ILTD\_ABC



(d') ILTD\_ABC



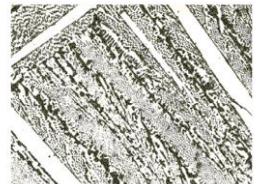
(e) ABC



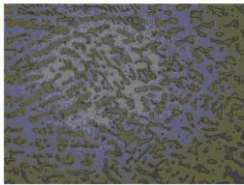
(f) ABC



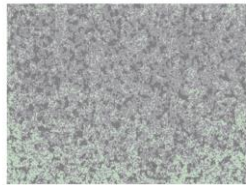
(g) ABC



(h) ABC



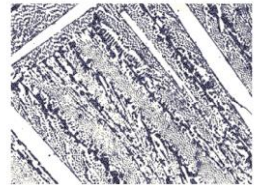
(e') ILTD\_ABC



(f') ILTD\_ABC



(g') ILTD\_ABC



(h') ILTD\_ABC

Fig. 2 Segmentation images,  $M - 1 = 6$