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APPENDIX A

Average PSNR value at various signal strength

Table A.1 Average PSNR value at various signal strength

Signal strength	Average PSNR value
0.06	34.32
0.07	32.99
0.08	31.86
0.09	30.83
0.10	29.92
0.11	29.11
0.12	28.35
0.13	27.66

APPENDIX B

Threshold and number elimination

Table B.1 Threshold with extracted watermark logo

Image	NC value					
	S=0.07	**S=0.08**	**S=0.09**	**S=0.10**	**S=0.11**	**S=0.12**
lena	0.682391	0.682391	0.682391	0.682391	0.682391	0.682391
fish	0.684471	0.684471	0.684471	0.684471	0.684471	0.684471
tower	0.683011	0.683011	0.683011	0.683011	0.683011	0.683011
bird	0.685153	0.685153	0.685153	0.685153	0.685153	0.685153
baboon	0.683671	0.683671	0.683671	0.683671	0.683671	0.683671
airplane	0.682645	0.682645	0.682645	0.682645	0.682645	0.682645
house	0.681656	0.681656	0.681656	0.681656	0.681656	0.681656
pepper	0.682165	0.682165	0.682165	0.682165	0.682165	0.682165
sunflower	0.680323	0.680323	0.680323	0.680323	0.680323	0.680323
bee	0.682690	0.682690	0.682690	0.682690	0.682690	0.682690

Table B.2 Threshold with image variance, remove up to 4

Image variance (%)	Average NC value
-95%	0.858532
-90%	0.865203
-85%	0.866029
-80%	0.866145
-75%	0.865933
-70%	0.865843
-65%	0.865576
-60%	0.865505
-55%	0.865425
-50%	0.865370
-45%	0.865364
-40%	0.865339
-35%	0.865371
-30%	0.865210
-25%	0.865153
-20%	0.865158
-15%	0.865049
-10%	0.865064
-5%	0.865174
0%	0.865207
5%	0.865222
10%	0.865229
15%	0.865267
20%	0.865362
25%	0.865404
30%	0.865406
35%	0.865355
40%	0.865328
45%	0.865311
50%	0.865335
55%	0.865328
60%	0.865234
65%	0.865203
70%	0.865195
75%	0.865149
80%	0.865113
85%	0.865118
90%	0.865144
95%	0.865110

Table B.3 Threshold with image variance, remove up to 3

Image variance (%)	Average NC value
-95%	0.861150
-90%	0.866013
-85%	0.866493
-80%	0.866509
-75%	0.866270
-70%	0.866113
-65%	0.865819
-60%	0.865746
-55%	0.865613
-50%	0.865493
-45%	0.865462
-40%	0.865412
-35%	0.865443
-30%	0.865268
-25%	0.865201
-20%	0.865176
-15%	0.865065
-10%	0.865078
-5%	0.865182
0%	0.865212
5%	0.865225
10%	0.865231
15%	0.865270
20%	0.865364
25%	0.865409
30%	0.865413
35%	0.865360
40%	0.865328
45%	0.865311
50%	0.865335
55%	0.865328
60%	0.865234
65%	0.865203
70%	0.865195
75%	0.865149
80%	0.865113
85%	0.865118
90%	0.865144
95%	0.865110

Table B.4 Threshold with image variance, remove up to 2

Image variance (%)	Average NC value
-95%	0.865831
-90%	0.868082
-85%	0.868171
-80%	0.867970
-75%	0.867599
-70%	0.867259
-65%	0.866915
-60%	0.866616
-55%	0.866352
-50%	0.866207
-45%	0.866040
-40%	0.865941
-35%	0.865913
-30%	0.865746
-25%	0.865617
-20%	0.865558
-15%	0.865404
-10%	0.865371
-5%	0.865391
0%	0.865374
5%	0.865358
10%	0.865352
15%	0.865357
20%	0.865432
25%	0.865461
30%	0.865448
35%	0.865392
40%	0.865348
45%	0.865323
50%	0.865330
55%	0.865323
60%	0.865218
65%	0.865193
70%	0.865189
75%	0.865148
80%	0.865124
85%	0.865122
90%	0.865145
95%	0.865106

Table B.5 Threshold with image variance, remove up to 4

Image variance (%)	Average NC value
-95%	0.867392
-90%	0.868001
-85%	0.867836
-80%	0.867665
-75%	0.867377
-70%	0.867075
-65%	0.866886
-60%	0.866723
-55%	0.866504
-50%	0.866371
-45%	0.866253
-40%	0.866129
-35%	0.866087
-30%	0.866003
-25%	0.86594
-20%	0.865797
-15%	0.865647
-10%	0.865604
-5%	0.865582
0%	0.865568
5%	0.865501
10%	0.865462
15%	0.865475
20%	0.865522
25%	0.865508
30%	0.86549
35%	0.865445
40%	0.865392
45%	0.865367
50%	0.865352
55%	0.865333
60%	0.865248
65%	0.865215
70%	0.865238
75%	0.865207
80%	0.86519
85%	0.865207
90%	0.86522
95%	0.865201

Table B.6 Threshold with region of image, remove up to 1

Number of region	Average NC value
4 region	0.865449
9 region	0.865528
16 region	0.865698
25 region	0.865613

Table B.7 Threshold with region of image, remove up to 2

Number of region	Average NC value
4 region	0.865373
9 region	0.865474
16 region	0.865635
25 region	0.865581

Table B.8 Threshold with region of image, remove up to 3

Number of region	Average NC value
4 region	0.865259
9 region	0.865315
16 region	0.865427
25 region	0.865333

Table B.9 Threshold with region of image, remove up to 4

Number of region	Average NC value
4 region	0.865231
9 region	0.865288
16 region	0.865381
25 region	0.865337

Table B.10 Threshold with window size of image variance, remove up to 1

Window size	Average NC value
3*3	0.8645295
5*5	0.8647056
7*7	0.8649072
9*9	0.8650659
11*11	0.8652339
13*13	0.8653079
15*15	0.8653705
17*17	0.8654079
19*19	0.8654969
21*21	0.8655300
23*23	0.8654708
25*25	0.8654460
27*27	0.8654276
29*29	0.8654191
31*31	0.8654163
33*33	0.8653873
35*35	0.8653826
37*37	0.8653813
39*39	0.8653694
41*41	0.8653644
43*43	0.8653744
45*45	0.8653644
47*47	0.8653694
49*49	0.8653694
51*51	0.8653619
256*256	0.8653644

Table B.11 Threshold with window size of image variance, remove up to 2

Window size	Average NC value
3*3	0.8645295
5*5	0.8642260
7*7	0.8644191
9*9	0.8646285
11*11	0.8649231
13*13	0.8650254
15*15	0.8650895
17*17	0.8651860
19*19	0.8652473
21*21	0.8653443
23*23	0.8652908
25*25	0.8652520
27*27	0.8652530
29*29	0.8652538
31*31	0.8652531
33*33	0.8652030
35*35	0.8652132
37*37	0.8652033
39*39	0.8651881
41*41	0.8651881
43*43	0.8651881
45*45	0.8651881
47*47	0.8651881
49*49	0.8651881
51*51	0.8651831
256*256	0.8651881

Table B.12 Threshold with window size of image variance, remove up to 3

Window size	Average NC value
3*3	0.8645295
5*5	0.8640918
7*7	0.8642583
9*9	0.8645030
11*11	0.8648070
13*13	0.8649025
15*15	0.8649705
17*17	0.8650843
19*19	0.8651453
21*21	0.8652425
23*23	0.8651753
25*25	0.8651455
27*27	0.8651535
29*29	0.8651528
31*31	0.8651503
33*33	0.8651005
35*35	0.8651118
37*37	0.8651013
39*39	0.8650810
41*41	0.8650910
43*43	0.8650910
45*45	0.8650810
47*47	0.8650810
49*49	0.8650910
51*51	0.8650710
256*256	0.8650810

Table B.13 Threshold with window size of image variance, remove up to 4

Window size	Average NC value
3*3	0.8645295
5*5	0.8640568
7*7	0.8642018
9*9	0.8644565
11*11	0.8647880
13*13	0.8648925
15*15	0.8649520
17*17	0.8650153
19*19	0.8651453
21*21	0.8652098
23*23	0.8651448
25*25	0.8651195
27*27	0.8651110
29*29	0.8651015
31*31	0.8651158
33*33	0.8650819
35*35	0.8650700
37*37	0.8650598
39*39	0.8650619
41*41	0.8650819
43*43	0.8650719
45*45	0.8650719
47*47	0.8650619
49*49	0.8650619
51*51	0.8650719
256*256	0.8650619

Table B.14 Threshold with image standard deviation, remove up to 2 couples

Standard deviation (%)	Average NC value	
	Previous [8]	Proposed
0	0.88373	0.89238
5	0.88373	0.89299
10	0.88373	0.89540
15	0.88373	0.90403
20	0.88373	0.90441
25	0.88373	0.90400
30	0.88373	0.90276
35	0.88373	0.90204
40	0.88373	0.90202
45	0.88373	0.90190
50	0.88373	0.90152
55	0.88373	0.90155
60	0.88373	0.90156
65	0.88373	0.90143
70	0.88373	0.90132
75	0.88373	0.90129
80	0.88373	0.90127

APPENDIX C

A Case of attacks

Table C.1 Average NC value with JPEG attack

JPEG quality (%)	Average NC value		
	Previous [8]	Proposed	Threshold
95	0.735477	0.738796	0.6864
85	0.709705	0.711402	0.6864
75	0.699386	0.700618	0.6864
65	0.699469	0.701968	0.6864
55	0.692555	0.692604	0.6864
45	0.691763	0.694177	0.6864
35	0.689869	0.690605	0.6864
25	0.686747	0.687830	0.6864
15	0.685399	0.686359	0.6864
5	0.683594	0.682901	0.6864

Table C.2 Average NC value with Gaussian noise attack

Variance of additive Gaussian distributed noise	Average NC value		
	Previous [8]	Proposed	Threshold
0.001	0.854070	0.874031	0.6864
0.05	0.732670	0.735215	0.6864
0.1	0.709309	0.710685	0.6864
0.2	0.698793	0.699908	0.6864
0.3	0.694482	0.695271	0.6864
0.4	0.691694	0.692050	0.6864
0.5	0.689725	0.689890	0.6864

Table C.3 Average NC value with Cropping attack

Cropping percentage (%)	Average NC value		
	Previous [8]	Proposed	Threshold
10	0.856593	0.875892	0.6864
20	0.836225	0.854161	0.6864
30	0.817517	0.834161	0.6864
40	0.795307	0.810625	0.6864
50	0.773374	0.786768	0.6864
60	0.751385	0.762077	0.6864
70	0.731916	0.740172	0.6864
80	0.711255	0.716936	0.6864
90	0.692044	0.694610	0.6864

Table C.4 Average NC value with Salt pepper noise attack

Salt pepper noise (%)	Average NC value		
	Previous [8]	**Proposed**	**Threshold**
0.01	0.841171	0.861412	0.6864
0.02	0.838702	0.858780	0.6864
0.03	0.835892	0.855882	0.6864
0.04	0.831928	0.852642	0.6864
0.05	0.828053	0.849746	0.6864
0.06	0.823327	0.846665	0.6864

Table C.5 Average NC value with Blurring attack

Blurring attack (%)	Average NC value		
	Previous [8]	**Proposed**	**Threshold**
2	0.829351	0.845123	0.6864
4	0.772888	0.782054	0.6864
6	0.763096	0.773274	0.6864
8	0.752721	0.764092	0.6864
12	0.729281	0.736861	0.6864
14	0.725256	0.731608	0.6864
20	0.716714	0.724073	0.6864

Table C.6 Average NC value with Brightness attack

Brightness attack (%)	Average NC value		
	Previous [8]	**Proposed**	**Threshold**
10	0.843530	0.863286	0.6864
20	0.833880	0.845248	0.6864
30	0.822249	0.844444	0.6864
40	0.821284	0.843038	0.6864
50	0.819896	0.842259	0.6864
60	0.819173	0.841558	0.6864
70	0.818474	0.840897	0.6864
80	0.817326	0.839305	0.6864
90	0.815108	0.836768	0.6864
100	0.811959	0.833208	0.6864

Table C.7 Average NC value with Contrast attack

Contrast scaling factor (%)	Average NC value		
	Previous [8]	**Proposed**	**Threshold**
1	0.843730	0.864814	0.6864
1.1	0.827946	0.844797	0.6864
1.2	0.820851	0.842815	0.6864
1.3	0.819336	0.841313	0.6864
1.4	0.818240	0.839921	0.6864
1.5	0.816407	0.837027	0.6864
1.6	0.813562	0.833807	0.6864
1.7	0.809677	0.829398	0.6864
1.8	0.805173	0.823405	0.6864
1.9	0.797948	0.815808	0.6864
2	0.790108	0.808279	0.6864

Table C.8 Average NC value with Sharpening filter attack

Sharpening filter (%)	Average NC value		
	Previous [8]	**Proposed**	**Threshold**
0.1	0.859026	0.837947	0.6864
0.2	0.843983	0.835040	0.6864
0.3	0.841387	0.833019	0.6864
0.4	0.840043	0.831996	0.6864
0.5	0.838282	0.831347	0.6864
0.6	0.836997	0.830982	0.6864
0.7	0.836101	0.830708	0.6864
0.8	0.835557	0.830840	0.6864
0.9	0.835268	0.830942	0.6864

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