

Retrieval Compensated Group Structured Sparsity for Image Super-Resolution Supplementary File

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I. SUBJECTIVE RESULTS

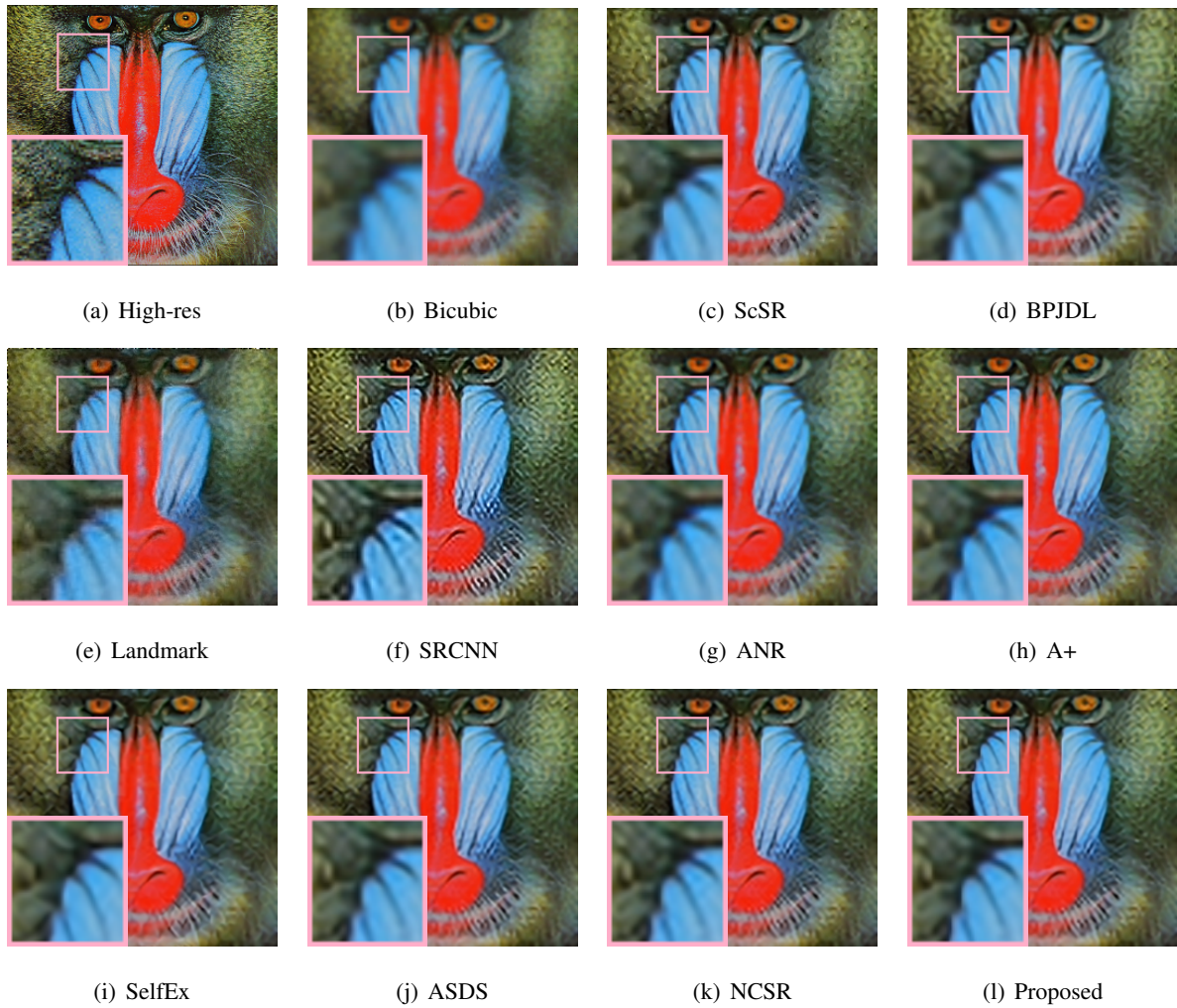


Fig. 1. Visual comparisons between different algorithms for the image *Baboon* ($3\times$).

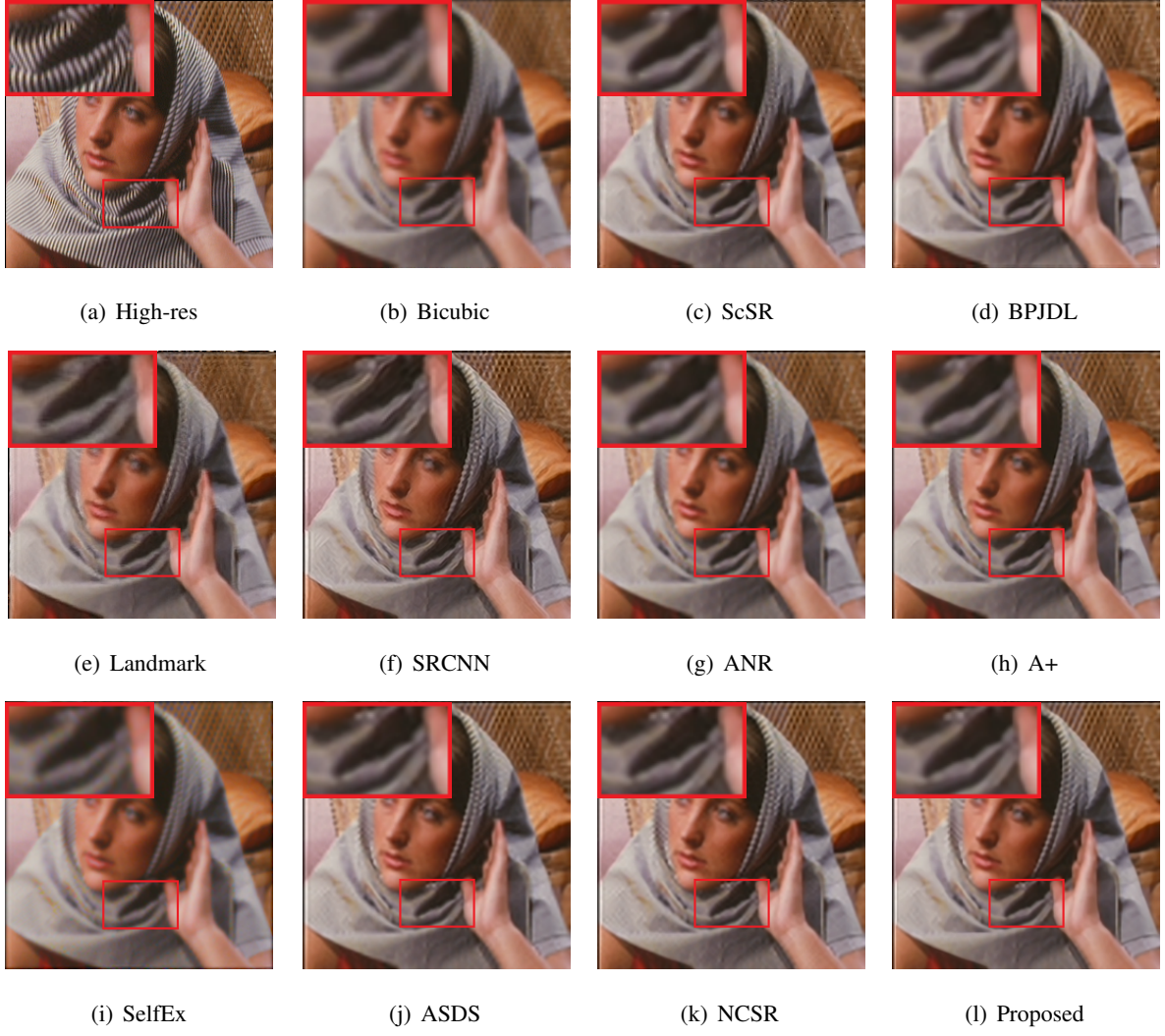


Fig. 2. Visual comparisons between different algorithms for the image *Barbara* ($3\times$).

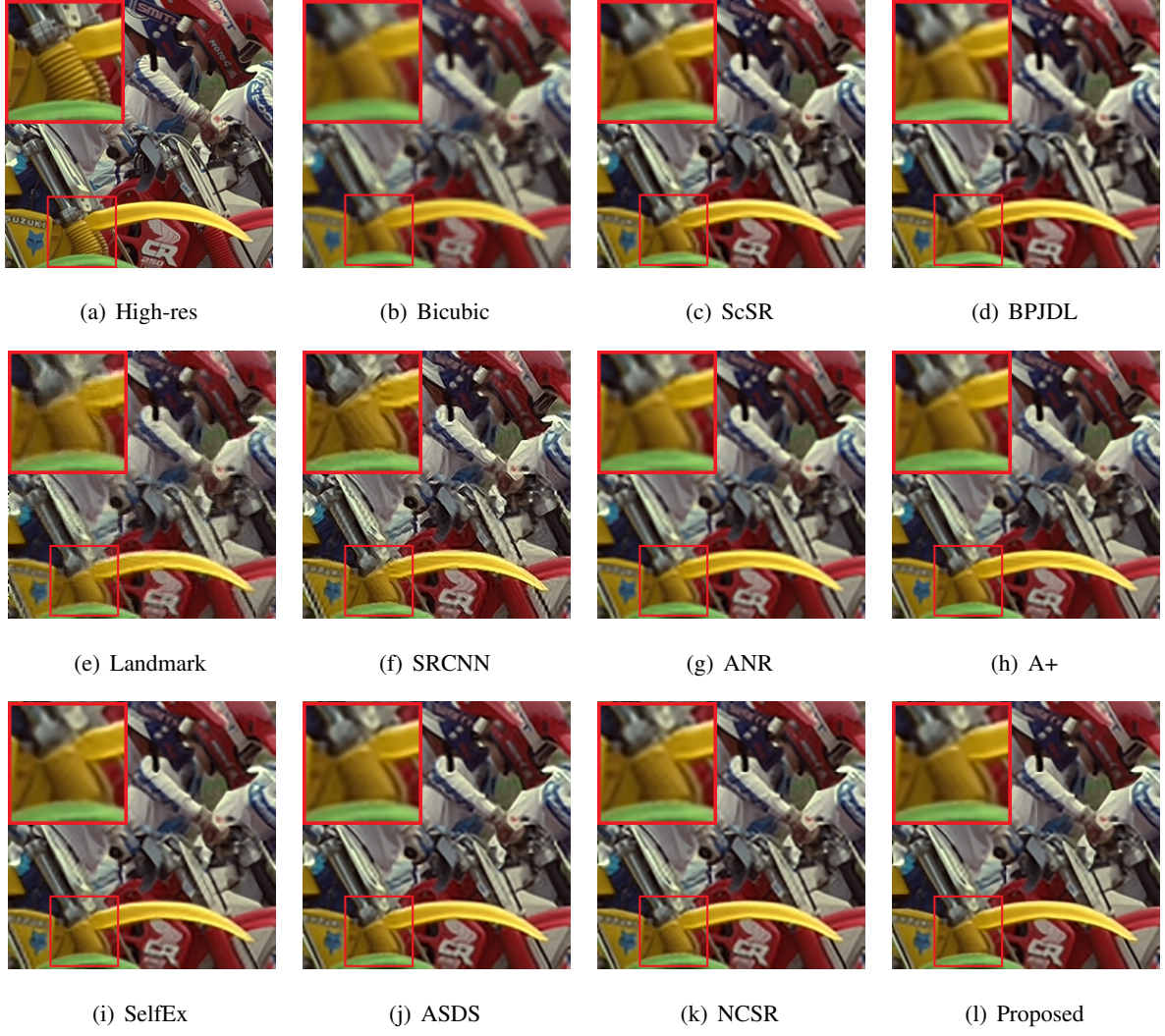


Fig. 3. Visual comparisons between different algorithms for the image *Bike* ($3\times$).



Fig. 4. Visual comparisons between different algorithms for the image *Butterfly* ($3\times$).

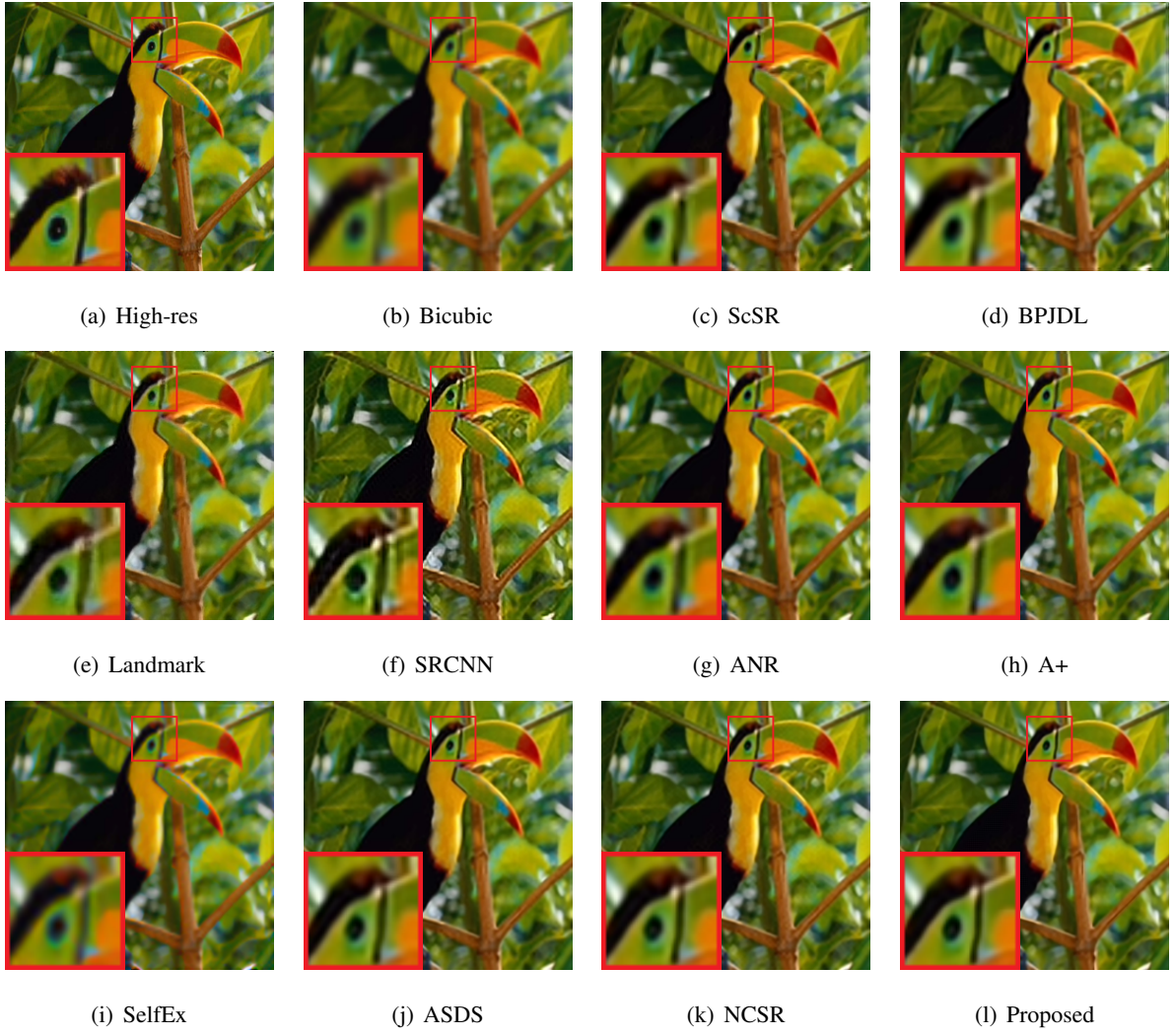


Fig. 5. Visual comparisons between different algorithms for the image *Bird* ($3\times$).

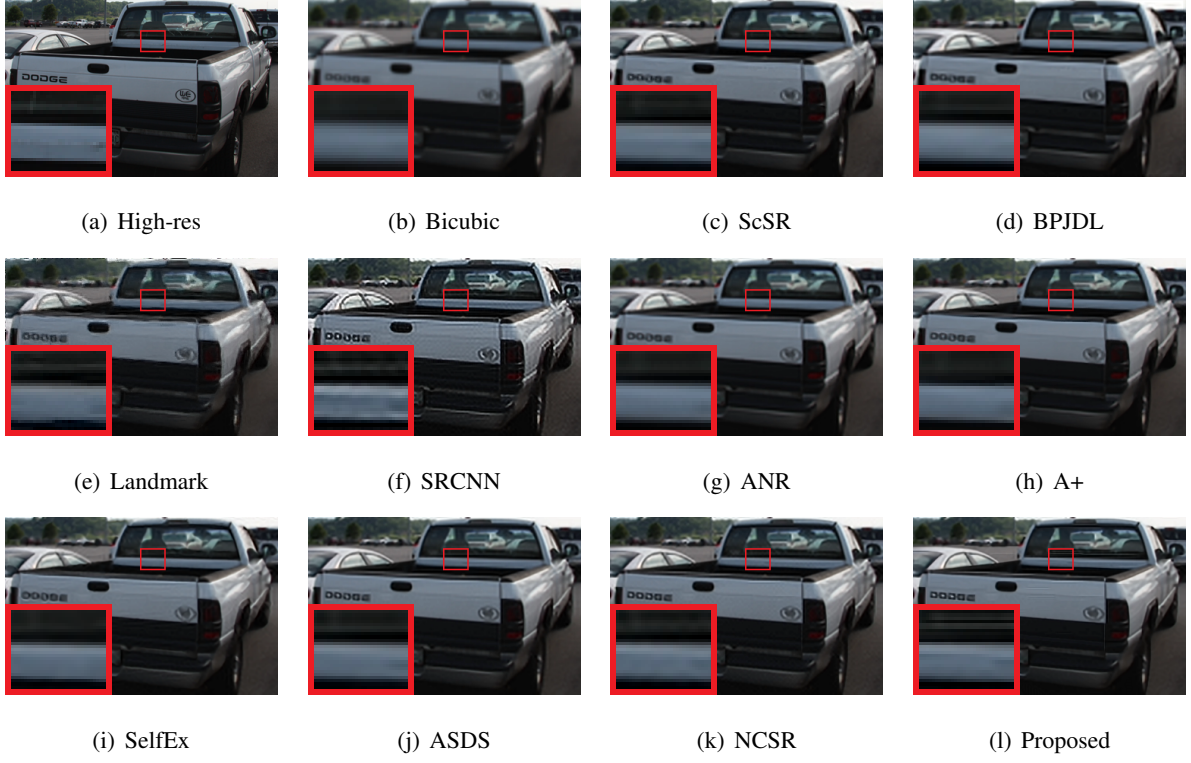


Fig. 6. Visual comparisons between different algorithms for the image *Car* ($3\times$).



Fig. 7. Visual comparisons between different algorithms for the image *Field* ($3\times$).

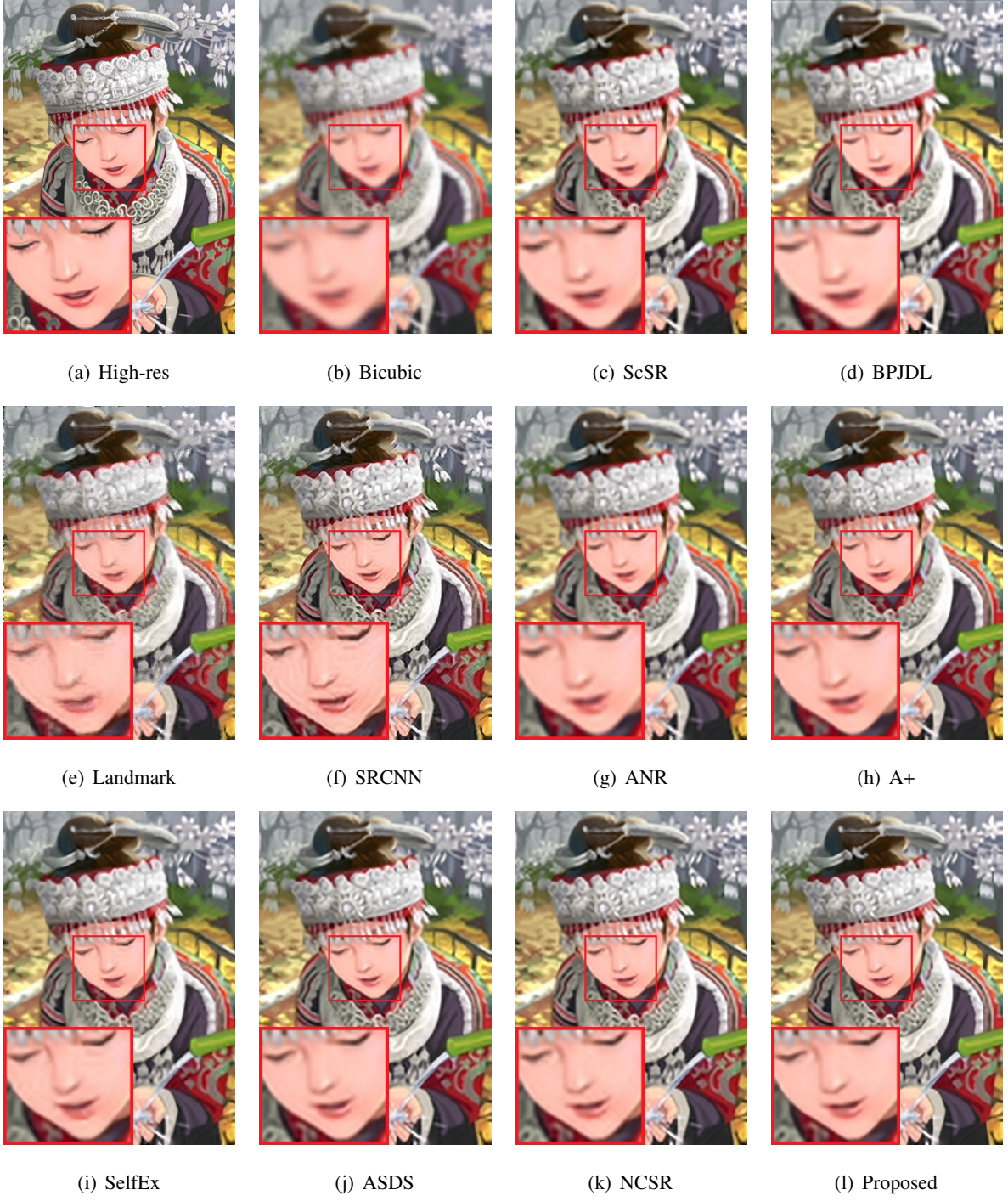


Fig. 8. Visual comparisons between different algorithms for the image *Comic* ($3\times$).

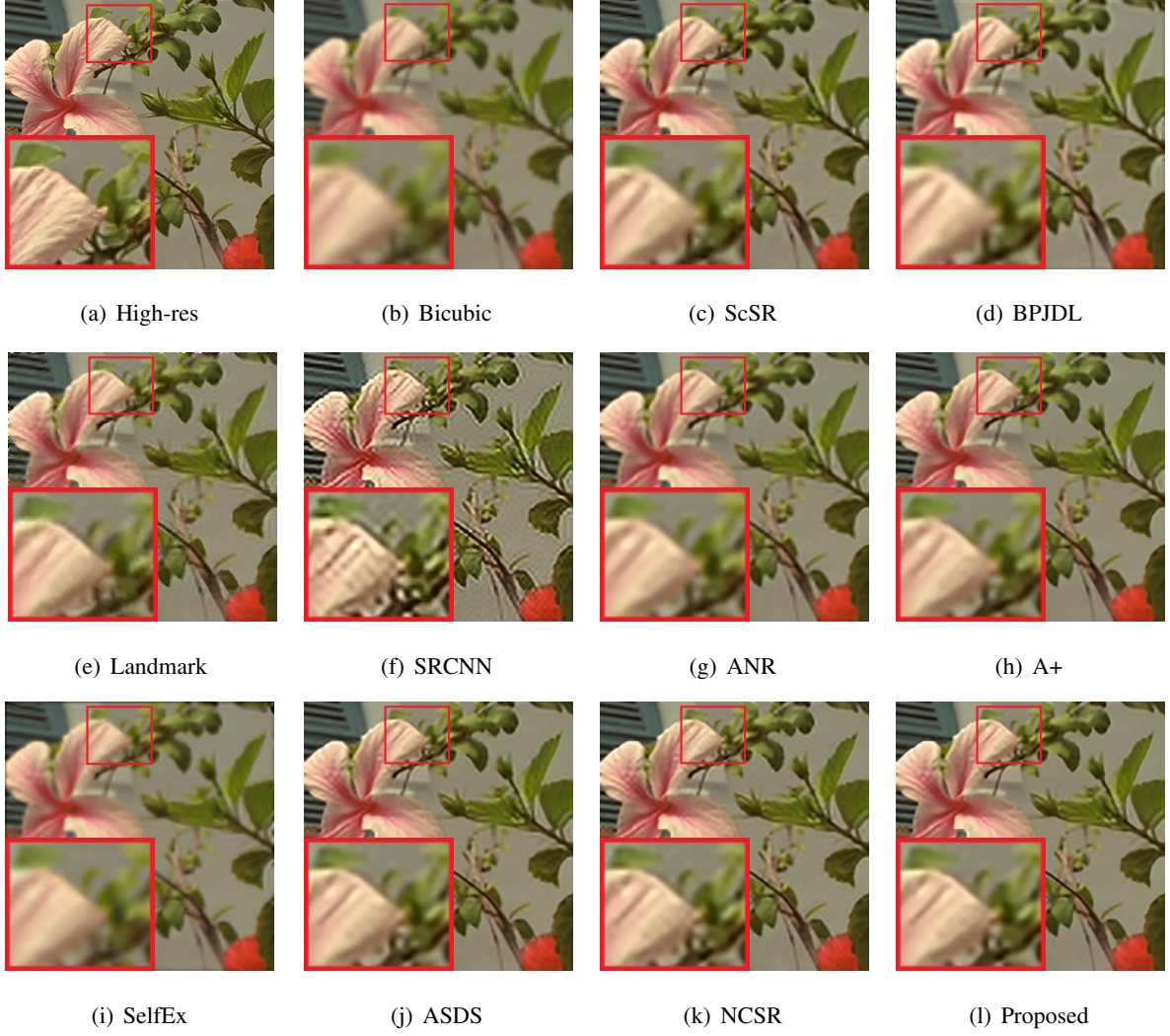


Fig. 9. Visual comparisons between different algorithms for the image *Flower* ($3\times$).



Fig. 10. Visual comparisons between different algorithms for the image *Flowers* ($3\times$).



Fig. 11. Visual comparisons between different algorithms for the image *Foreman* ($3\times$).

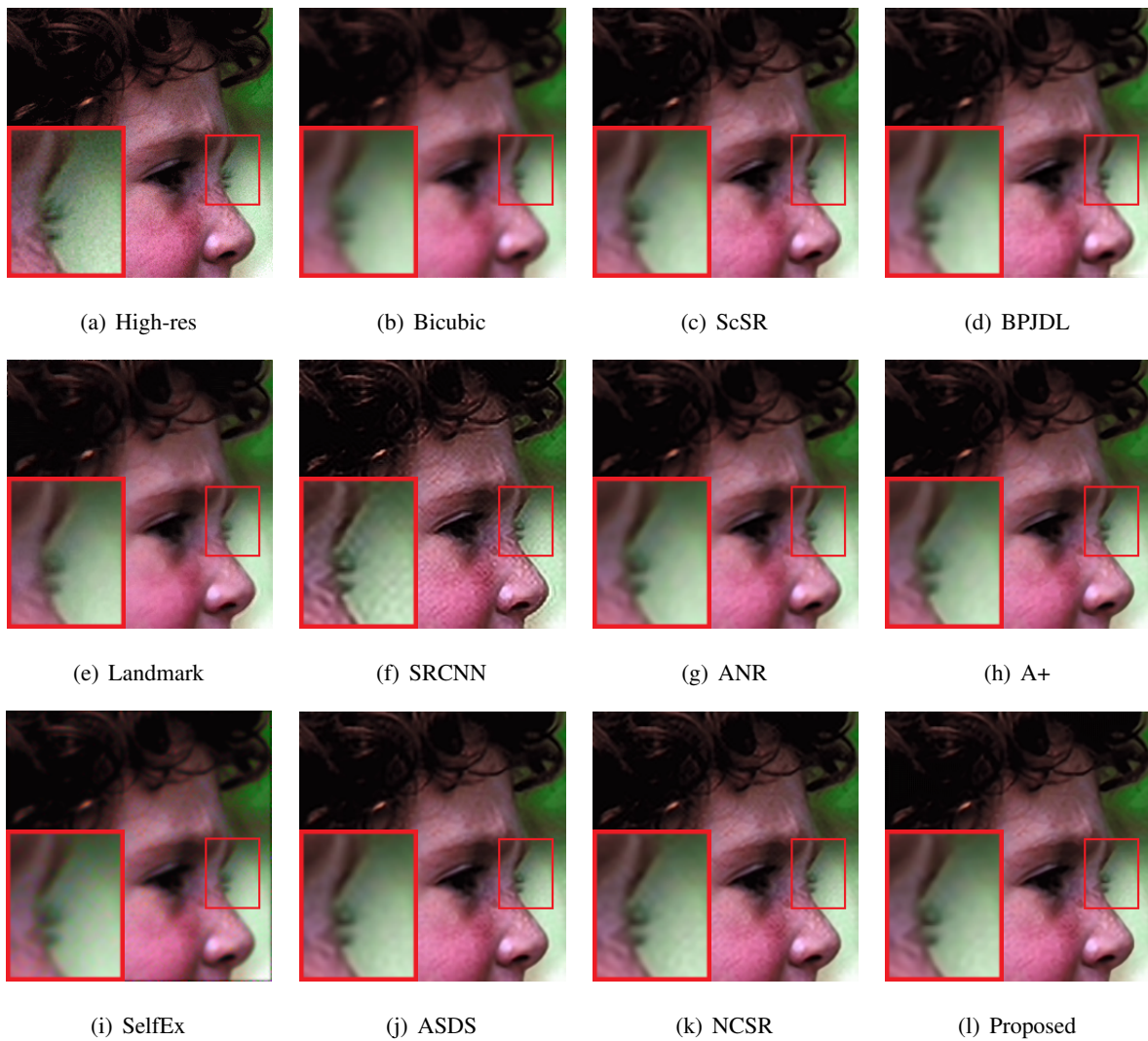


Fig. 12. Visual comparisons between different algorithms for the image *Girl* ($3\times$).

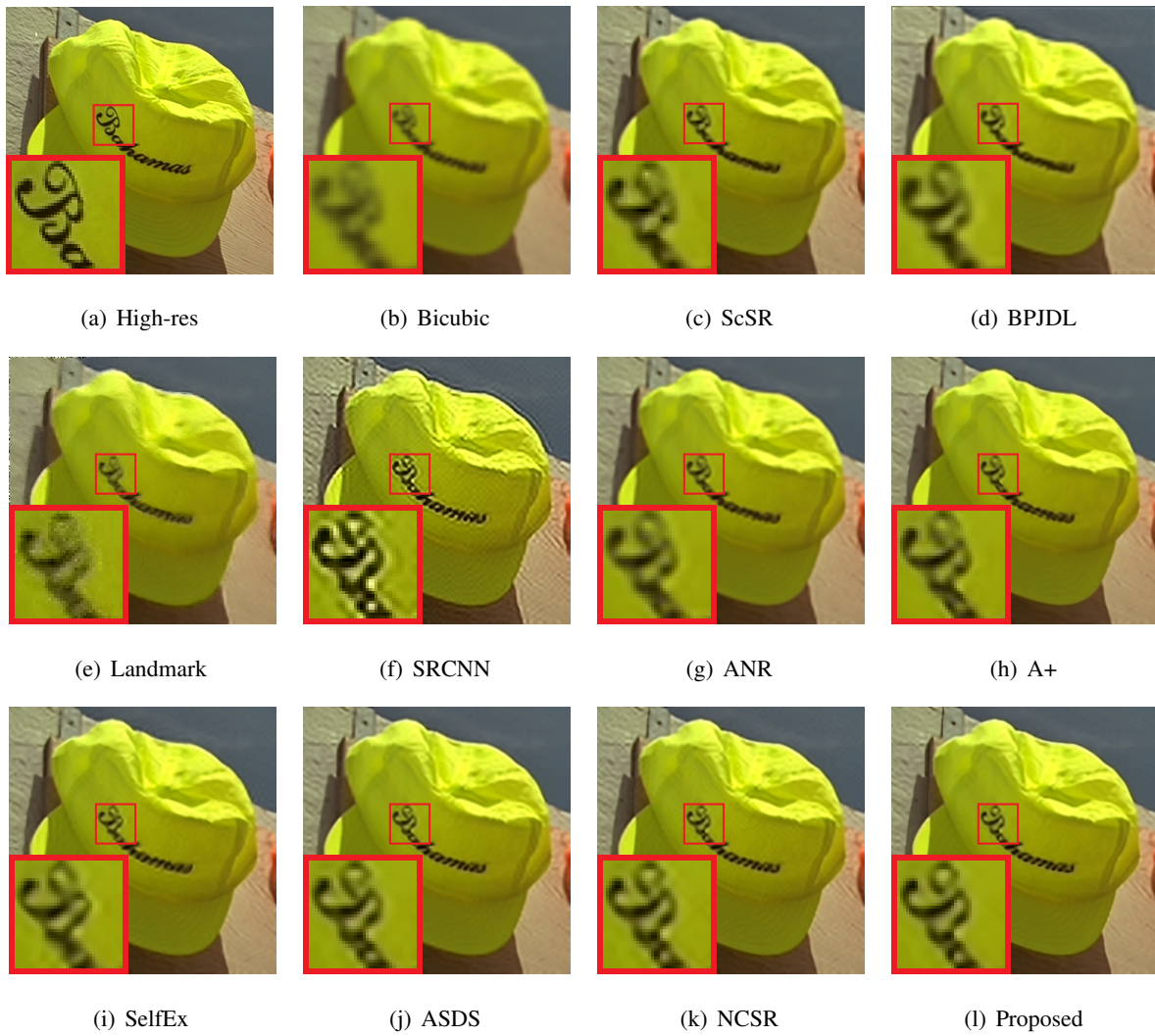


Fig. 13. Visual comparisons between different algorithms for the image *Hat* ($3\times$).



Fig. 14. Visual comparisons between different algorithms for the image *House* ($3\times$).



Fig. 15. Visual comparisons between different algorithms for the image *Leaves* ($3\times$).

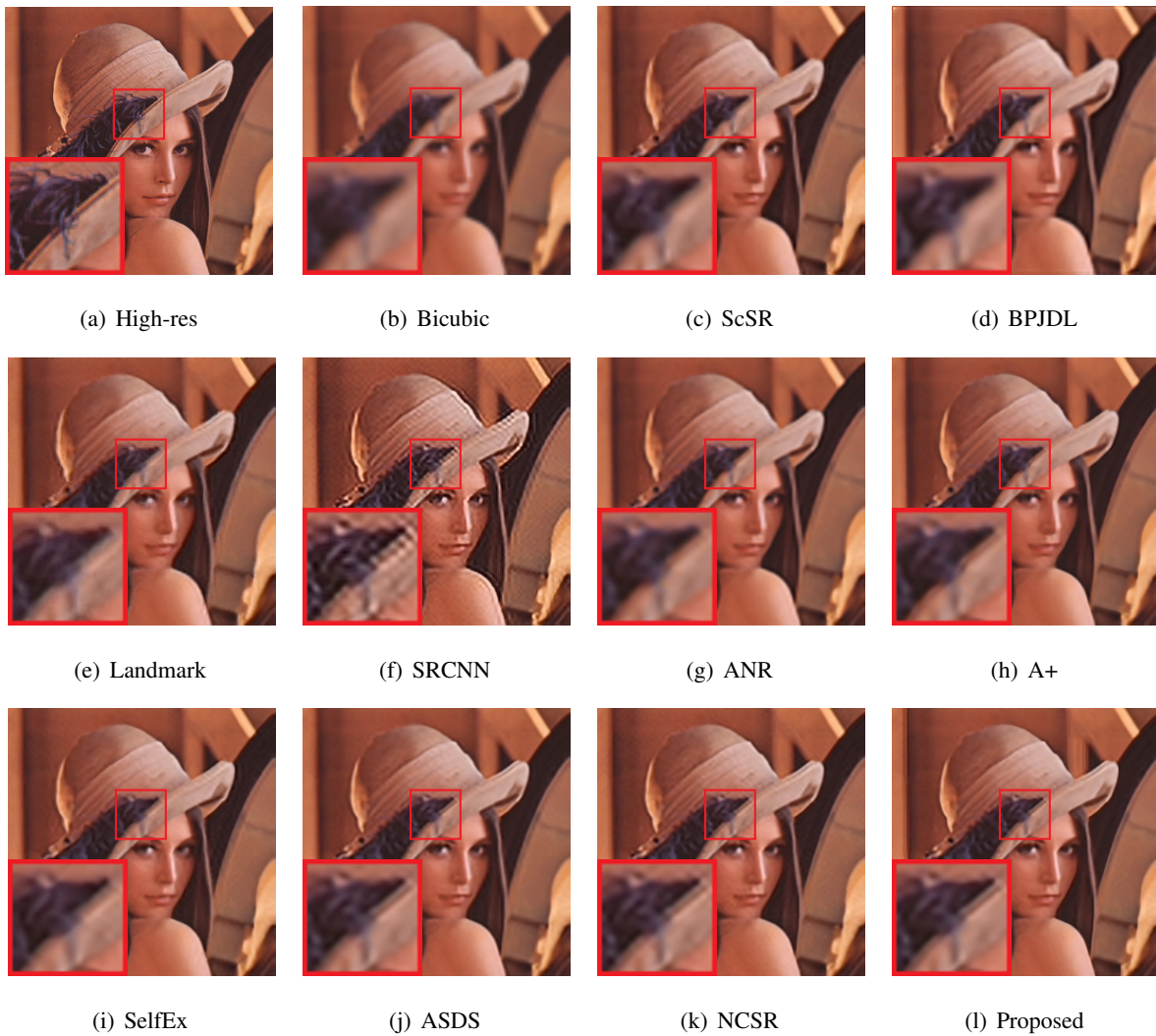


Fig. 16. Visual comparisons between different algorithms for the image *Lena* ($3\times$).

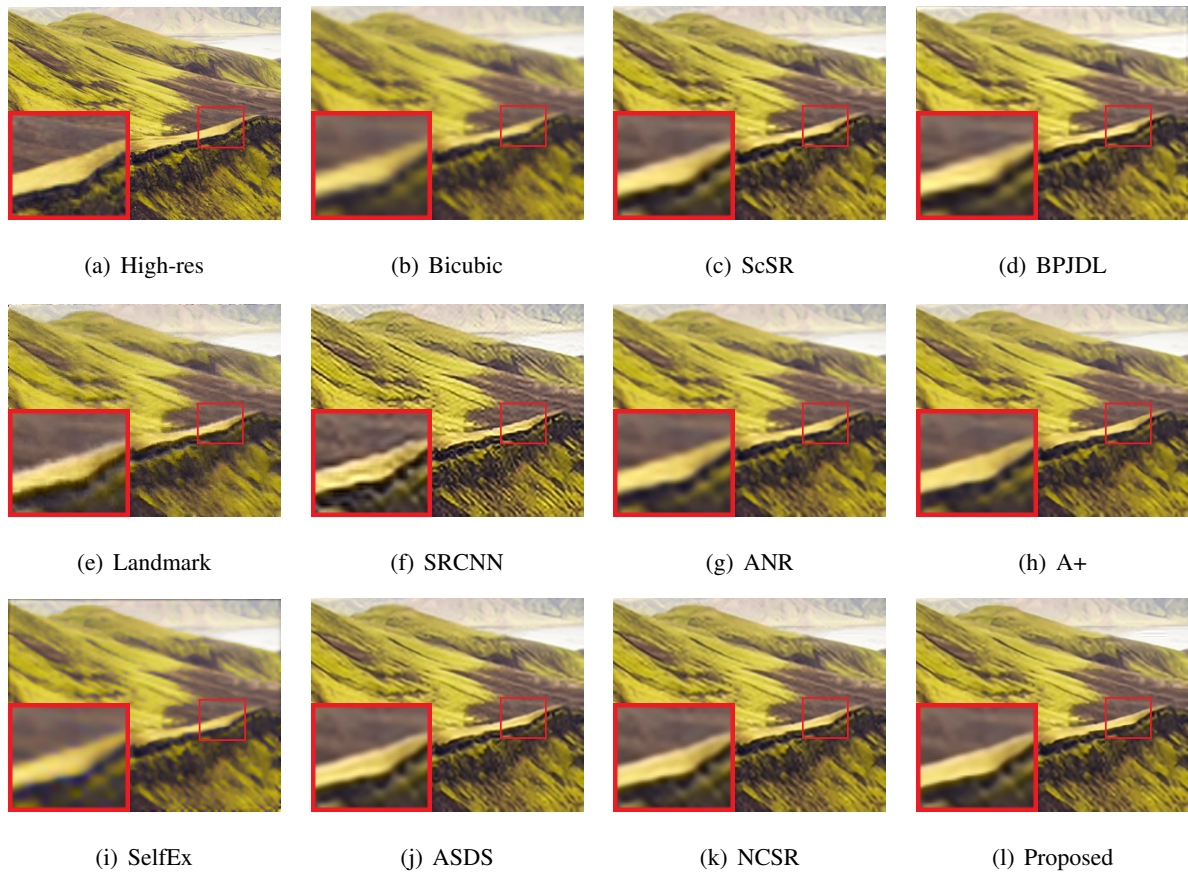


Fig. 17. Visual comparisons between different algorithms for the image *Mountain* ($3\times$).

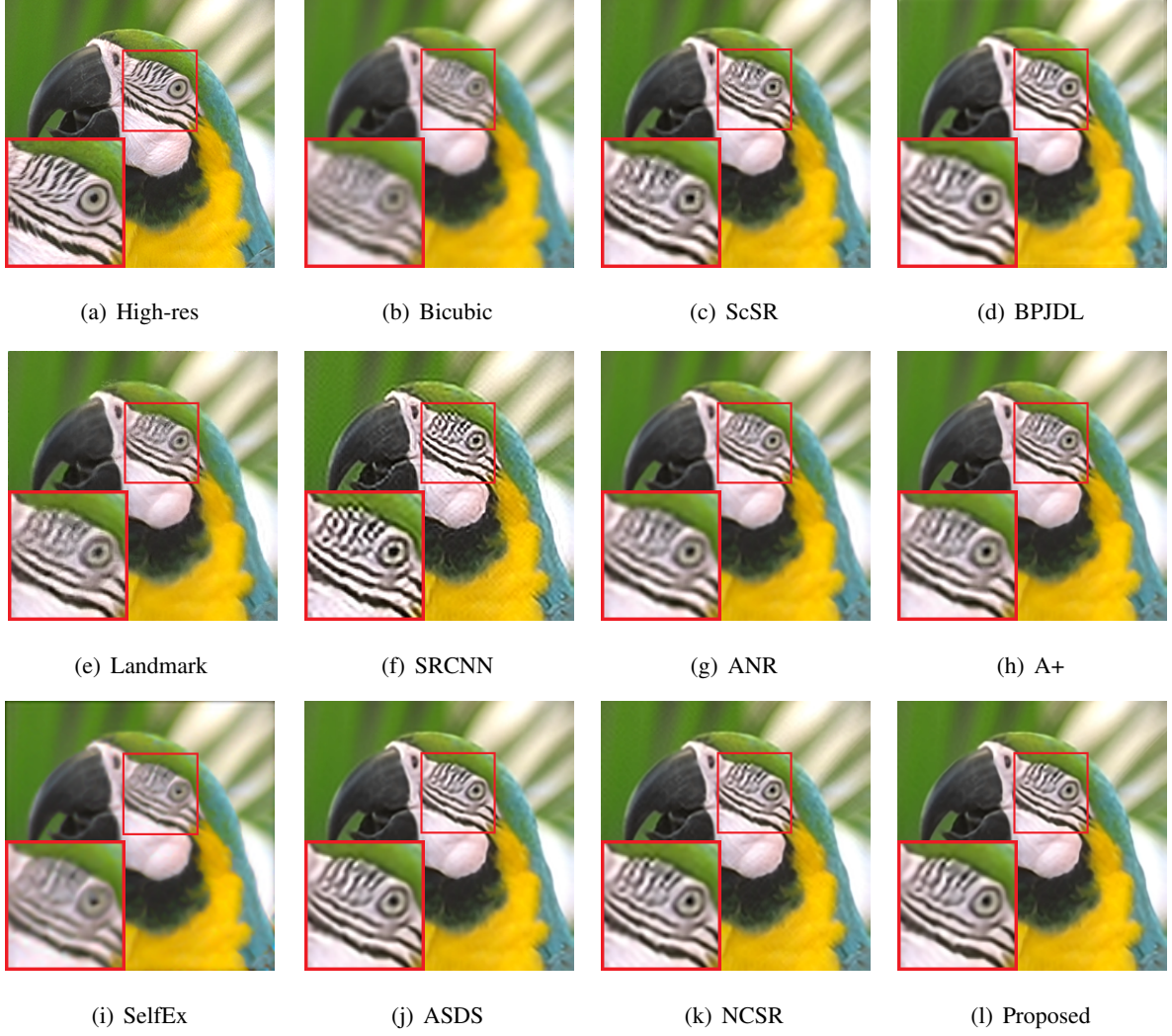


Fig. 18. Visual comparisons between different algorithms for the image *Parrots* ($3\times$).



Fig. 19. Visual comparisons between different algorithms for the image *Parthenon* ($3\times$).

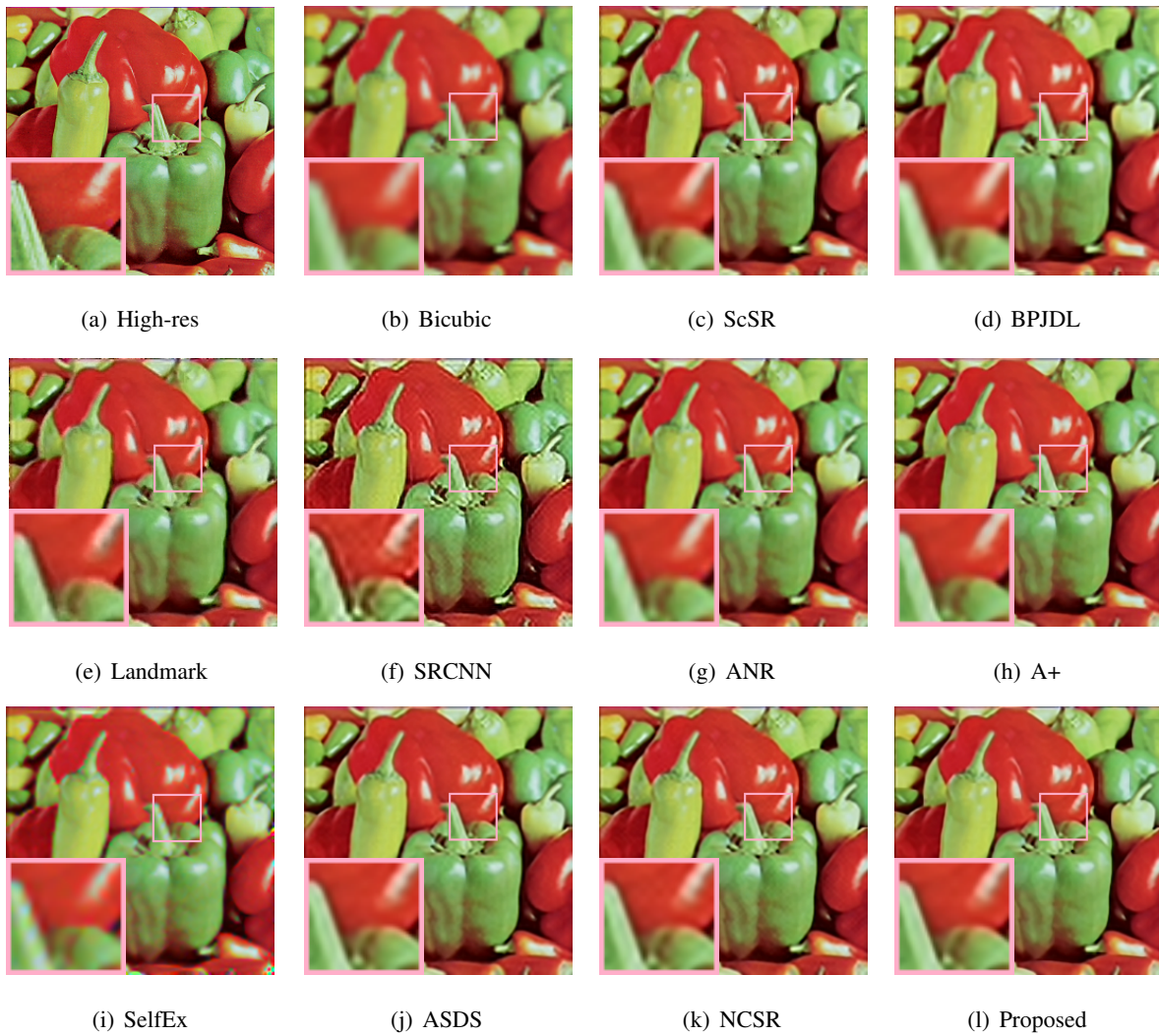


Fig. 20. Visual comparisons between different algorithms for the image *Pepper* ($3\times$).



Fig. 21. Visual comparisons between different algorithms for the image *Plants* ($3\times$).

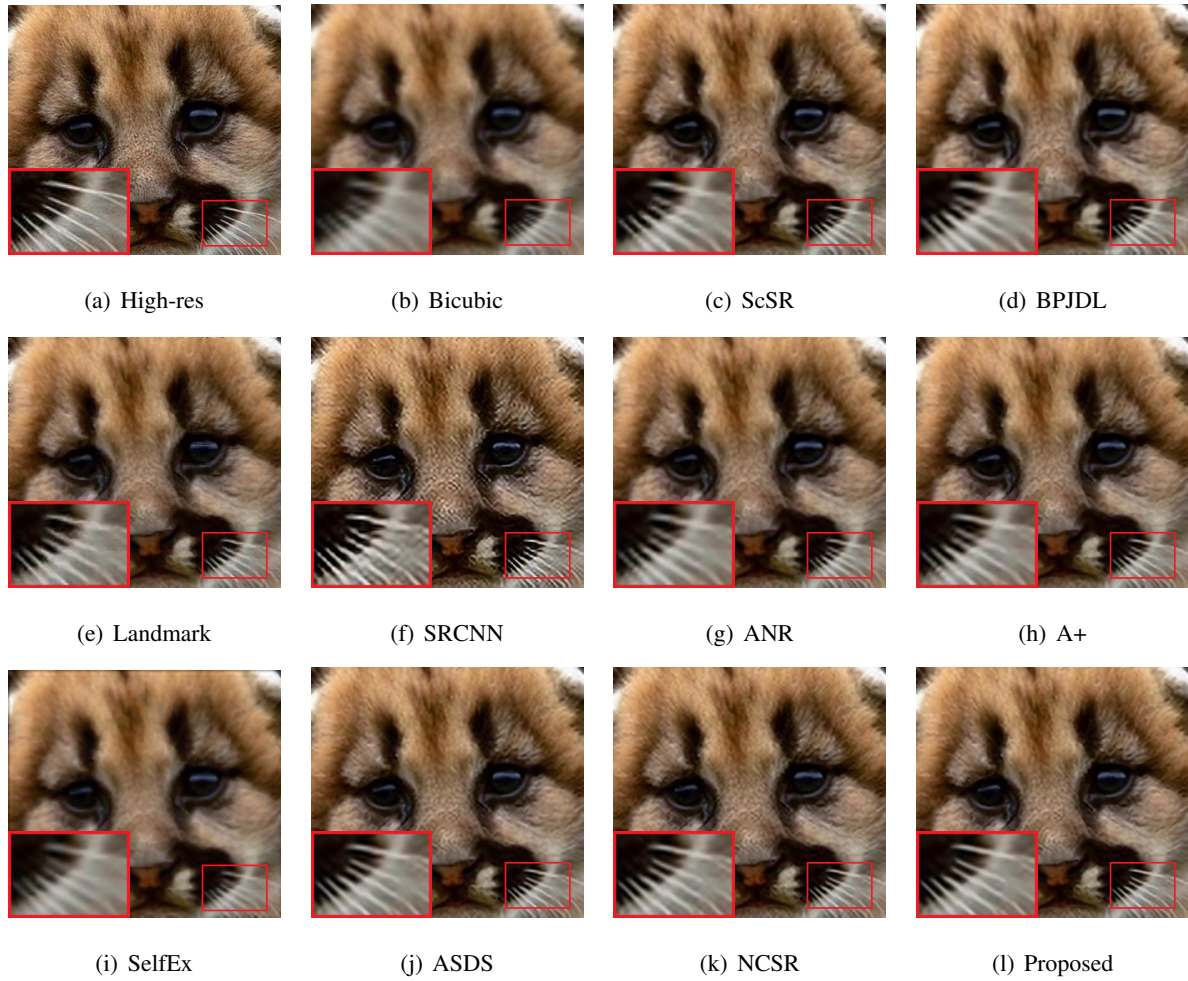


Fig. 22. Visual comparisons between different algorithms for the image *Raccoon* ($3\times$).



Fig. 23. Visual comparisons between different algorithms for the image *Starfish* ($3\times$).

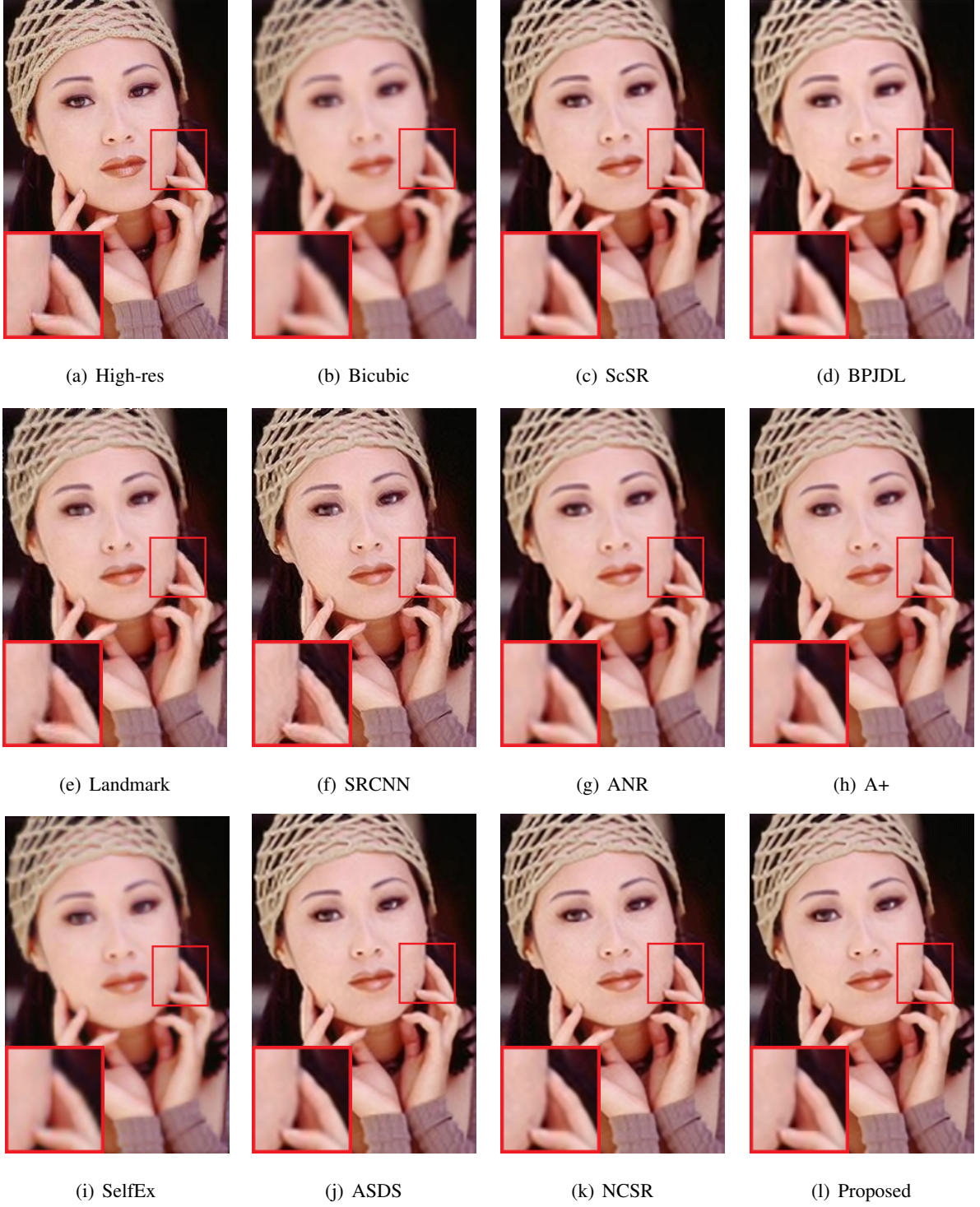


Fig. 24. Visual comparisons between different algorithms for the image *Woman* ($3\times$).

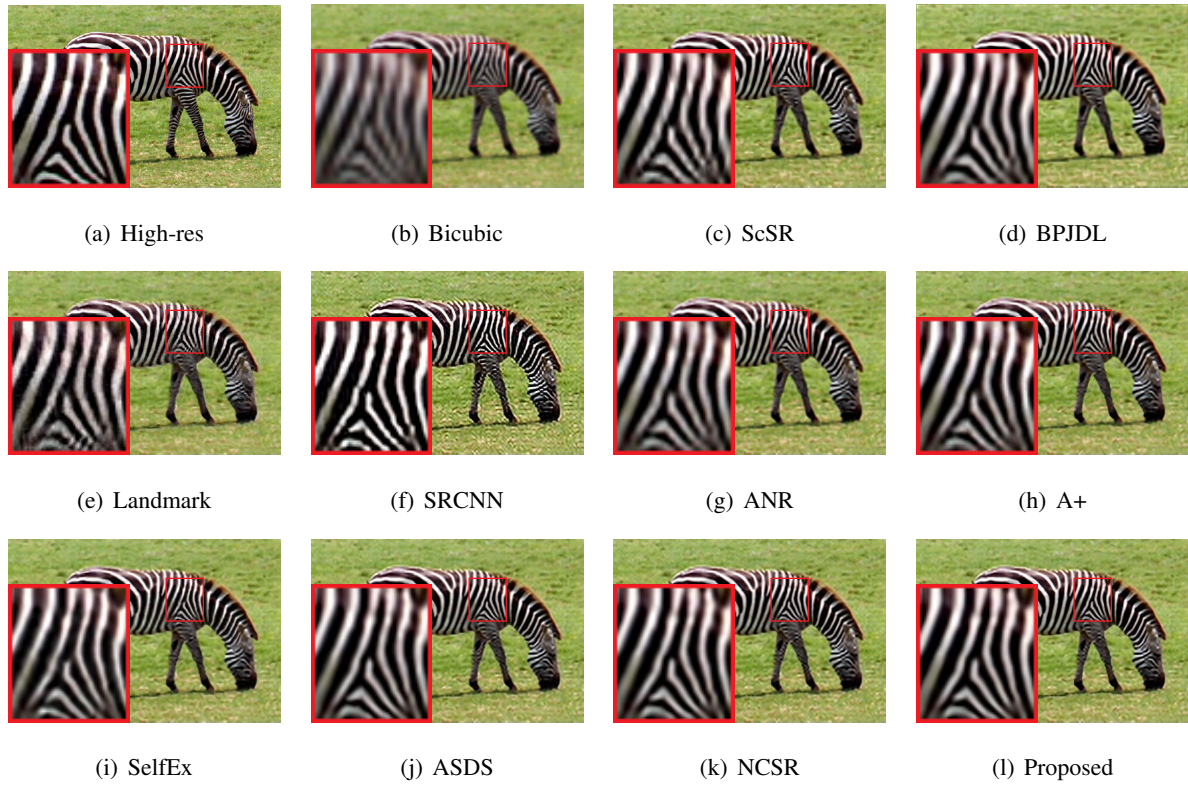


Fig. 25. Visual comparisons between different algorithms for the image *Zebra* ($3\times$).



Fig. 26. Visual comparisons between different algorithms for the image *Text* (3 $\times$).



Fig. 27. Visual comparisons between different algorithms for the image *Baboon* ($2\times$).

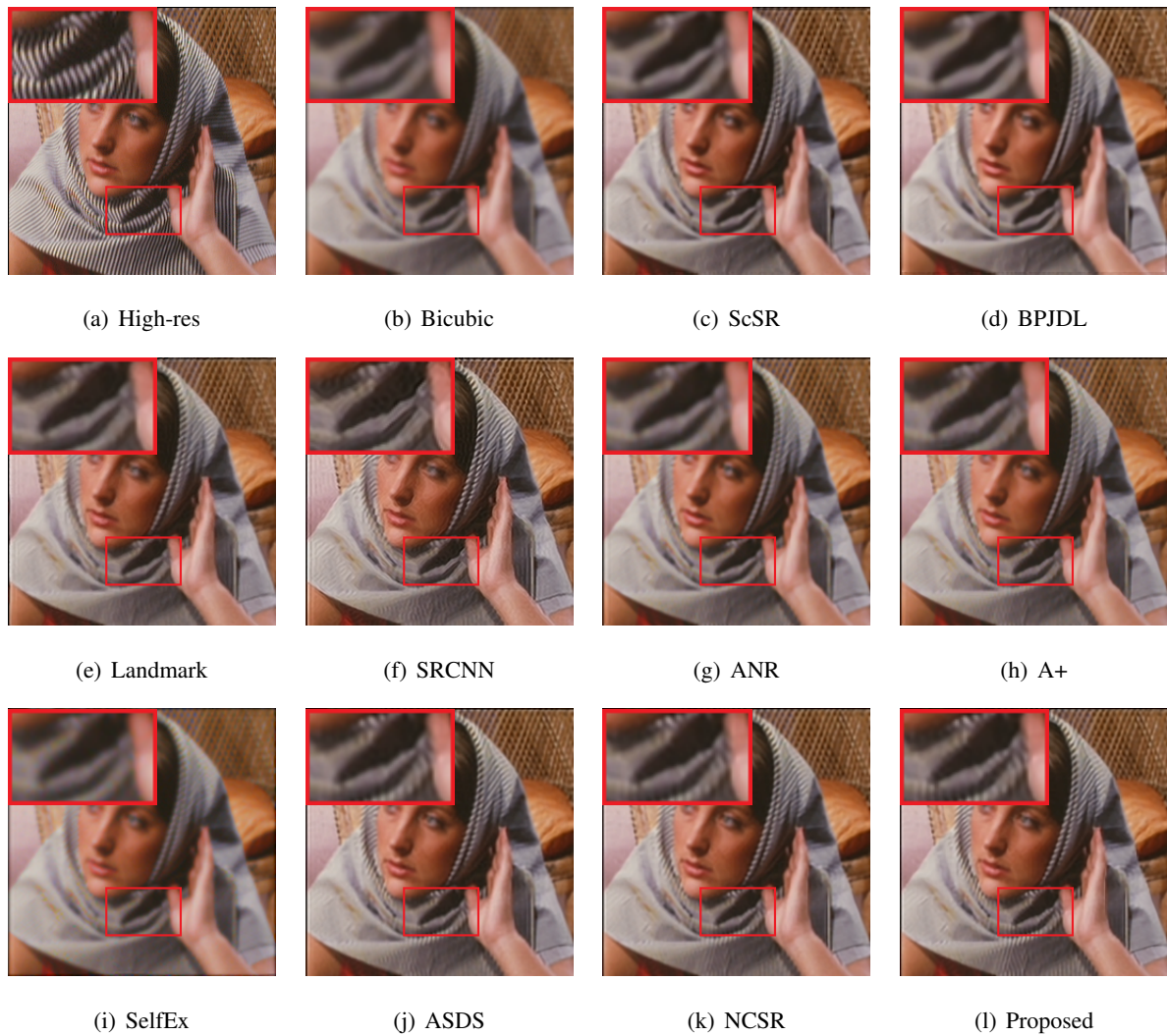


Fig. 28. Visual comparisons between different algorithms for the image *Barbara* ($2\times$).

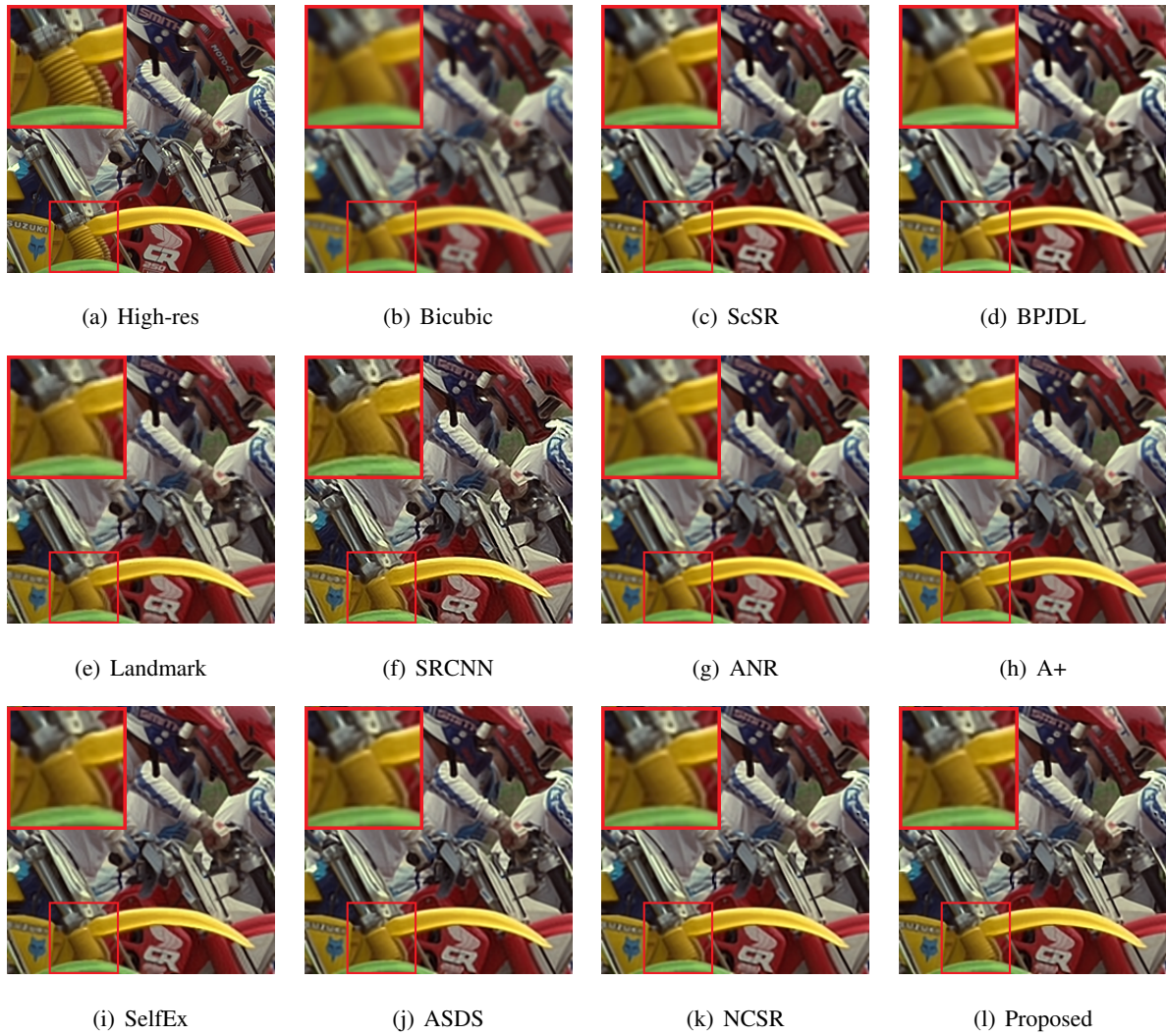


Fig. 29. Visual comparisons between different algorithms for the image *Bike* ($2\times$).



Fig. 30. Visual comparisons between different algorithms for the image *Butterfly* ($2\times$).

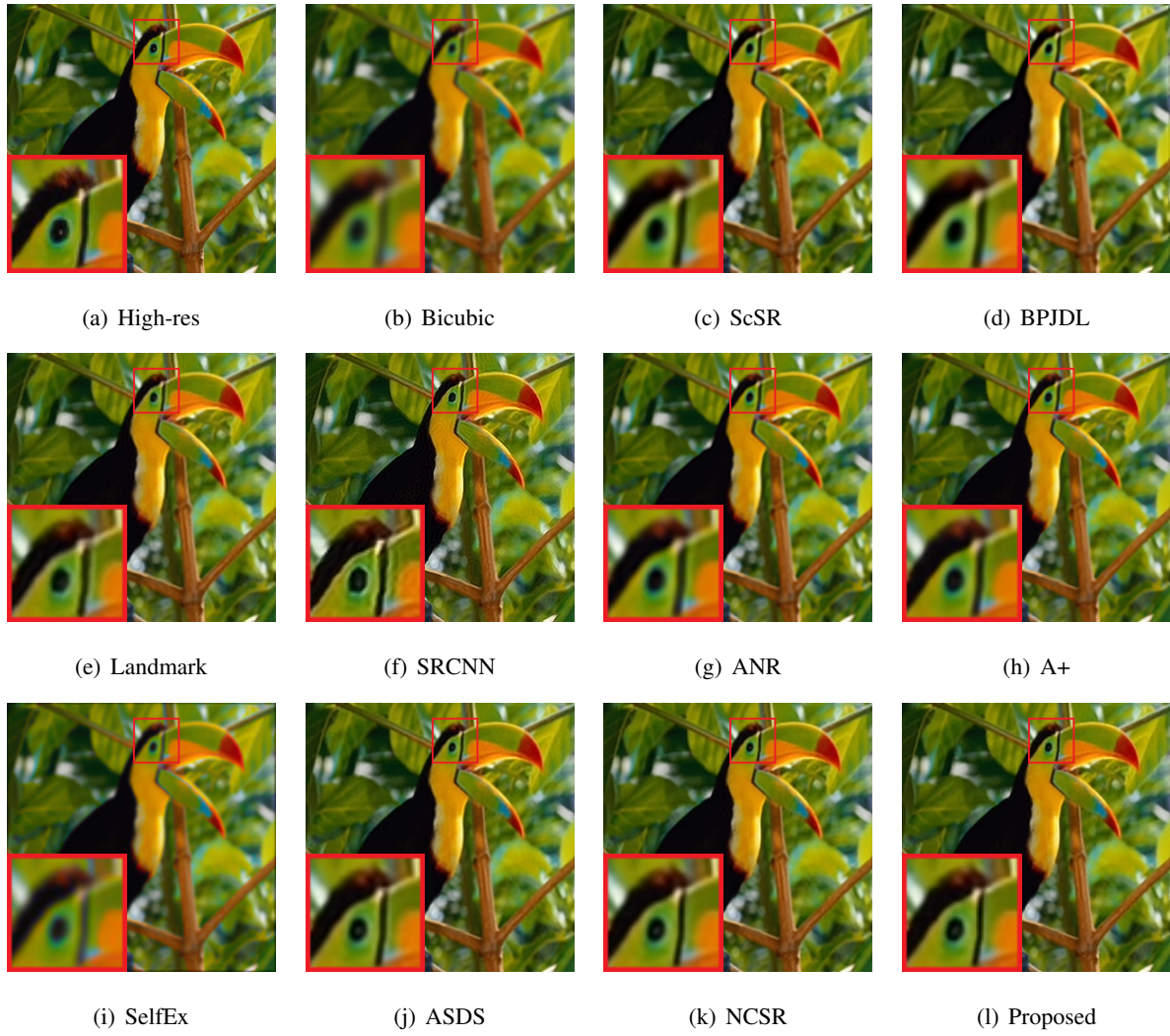


Fig. 31. Visual comparisons between different algorithms for the image *Bird* ($2\times$).



Fig. 32. Visual comparisons between different algorithms for the image *Car* ($2\times$).



Fig. 33. Visual comparisons between different algorithms for the image *Field* ($2\times$).

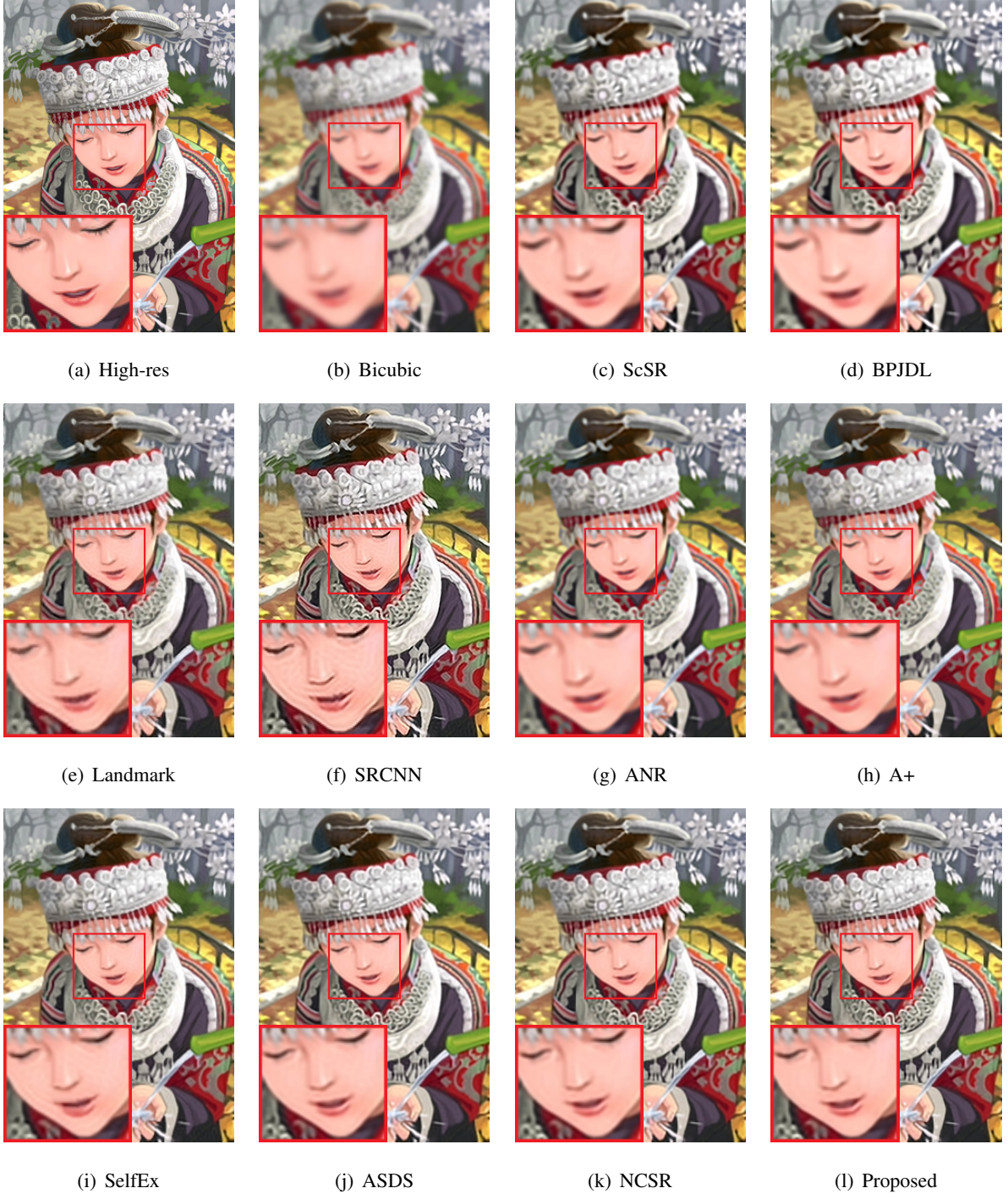


Fig. 34. Visual comparisons between different algorithms for the image *Comic* (2 $\times$).

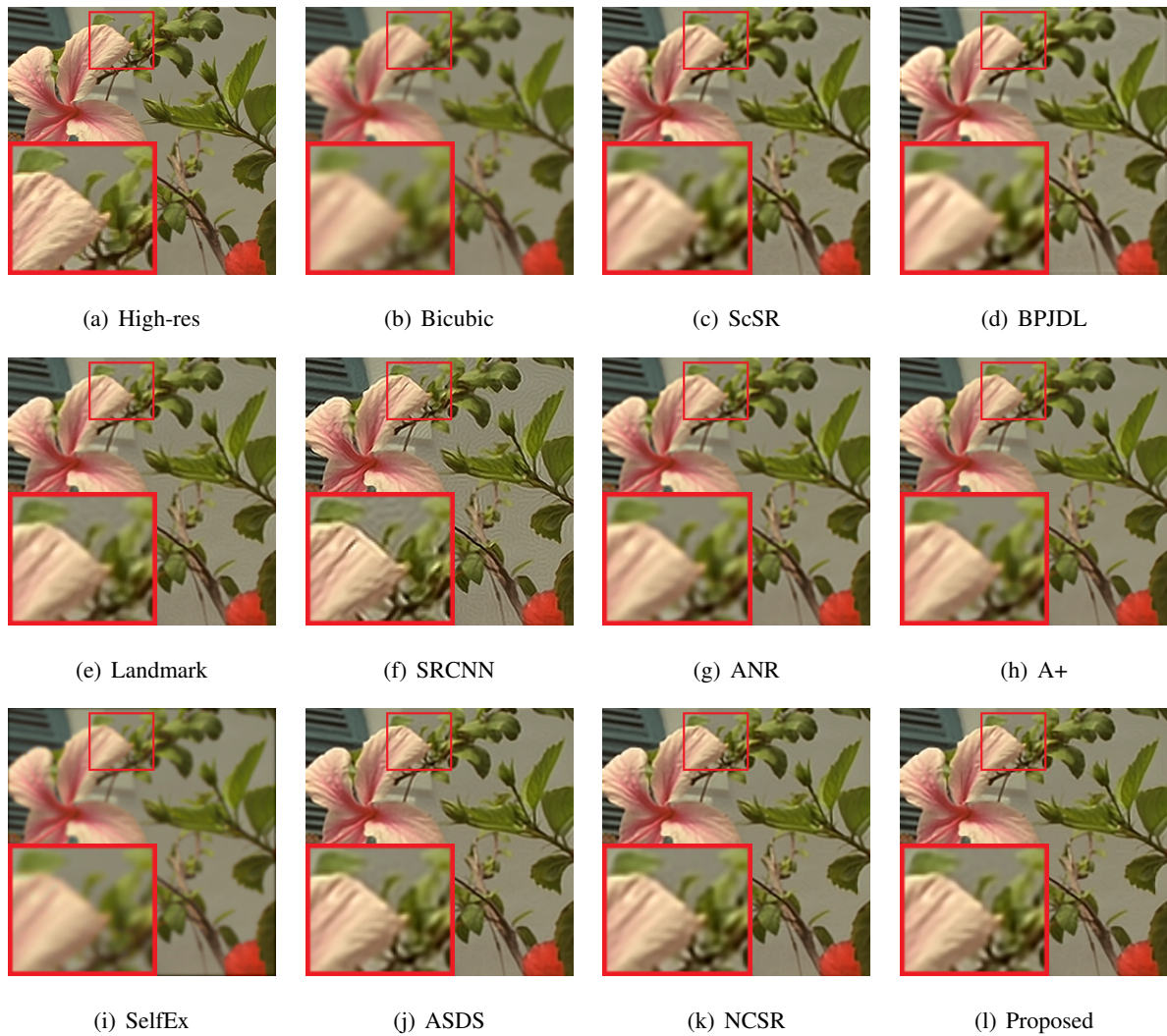


Fig. 35. Visual comparisons between different algorithms for the image *Flower* ($2\times$).



Fig. 36. Visual comparisons between different algorithms for the image *Flowers* ($2\times$).



Fig. 37. Visual comparisons between different algorithms for the image *Foreman* ($2\times$).

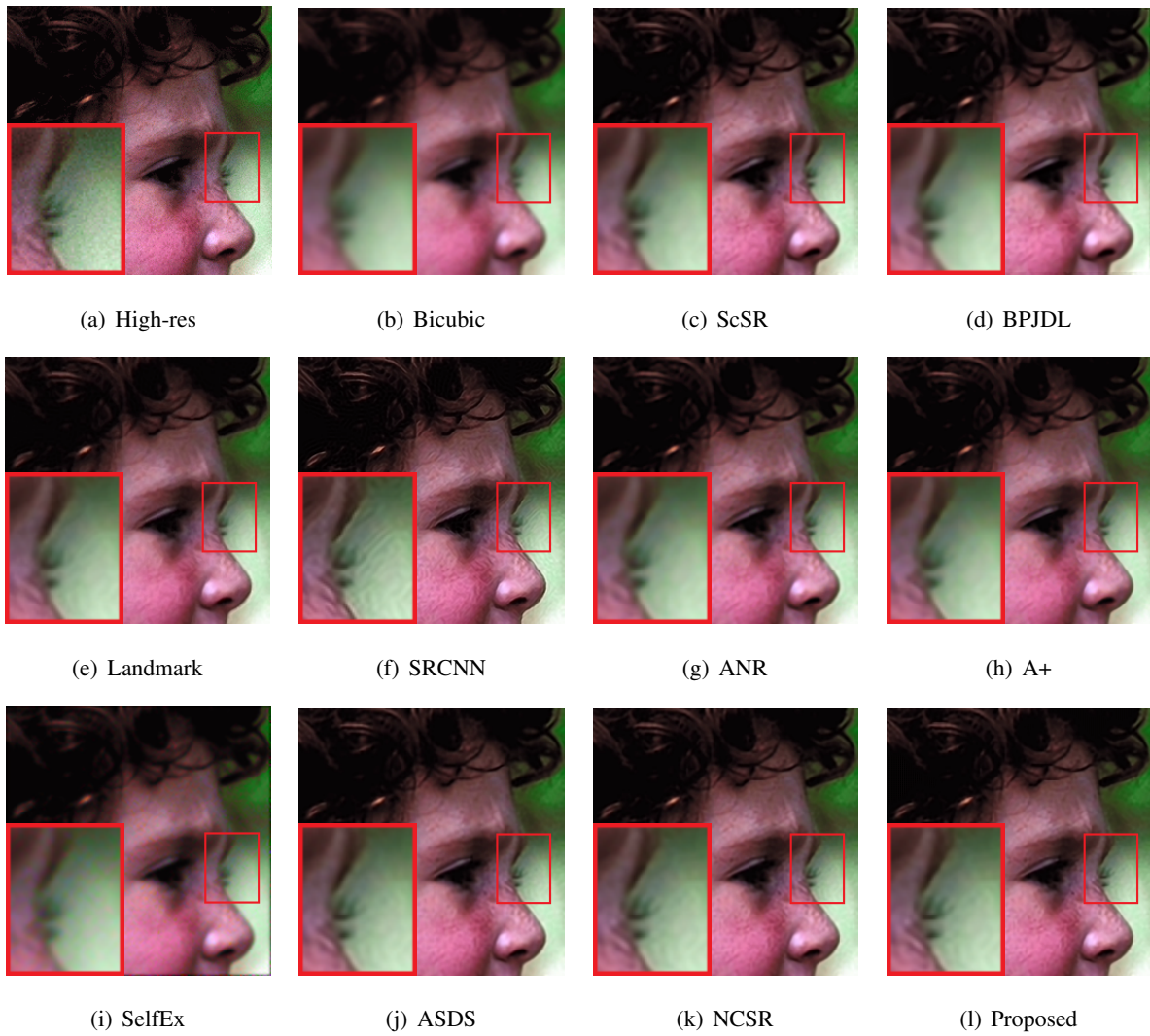


Fig. 38. Visual comparisons between different algorithms for the image *Girl* ($2\times$).

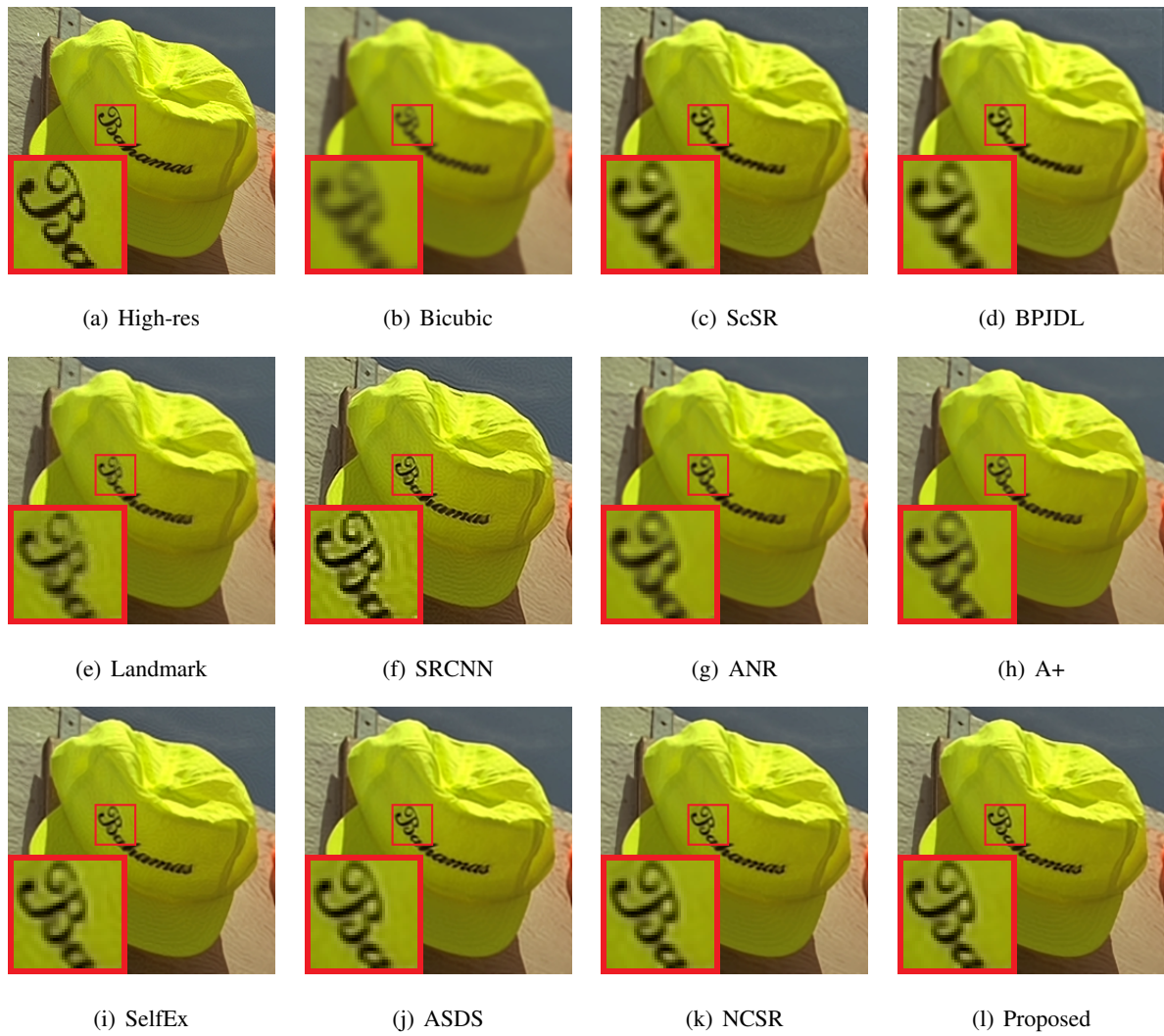


Fig. 39. Visual comparisons between different algorithms for the image *Hat* ($2\times$).



Fig. 40. Visual comparisons between different algorithms for the image *House* ($2\times$).

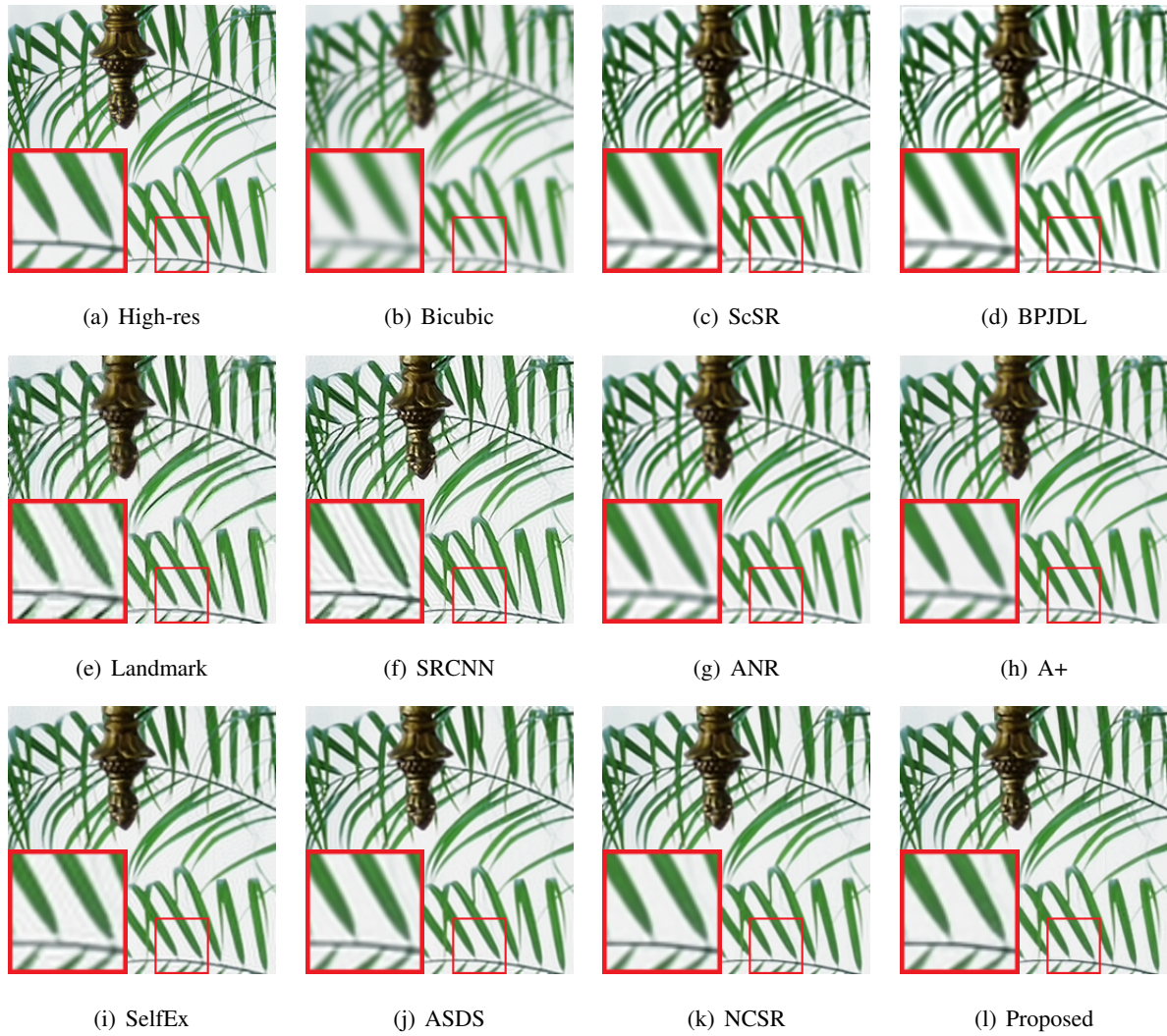


Fig. 41. Visual comparisons between different algorithms for the image *Leaves* ($2\times$).

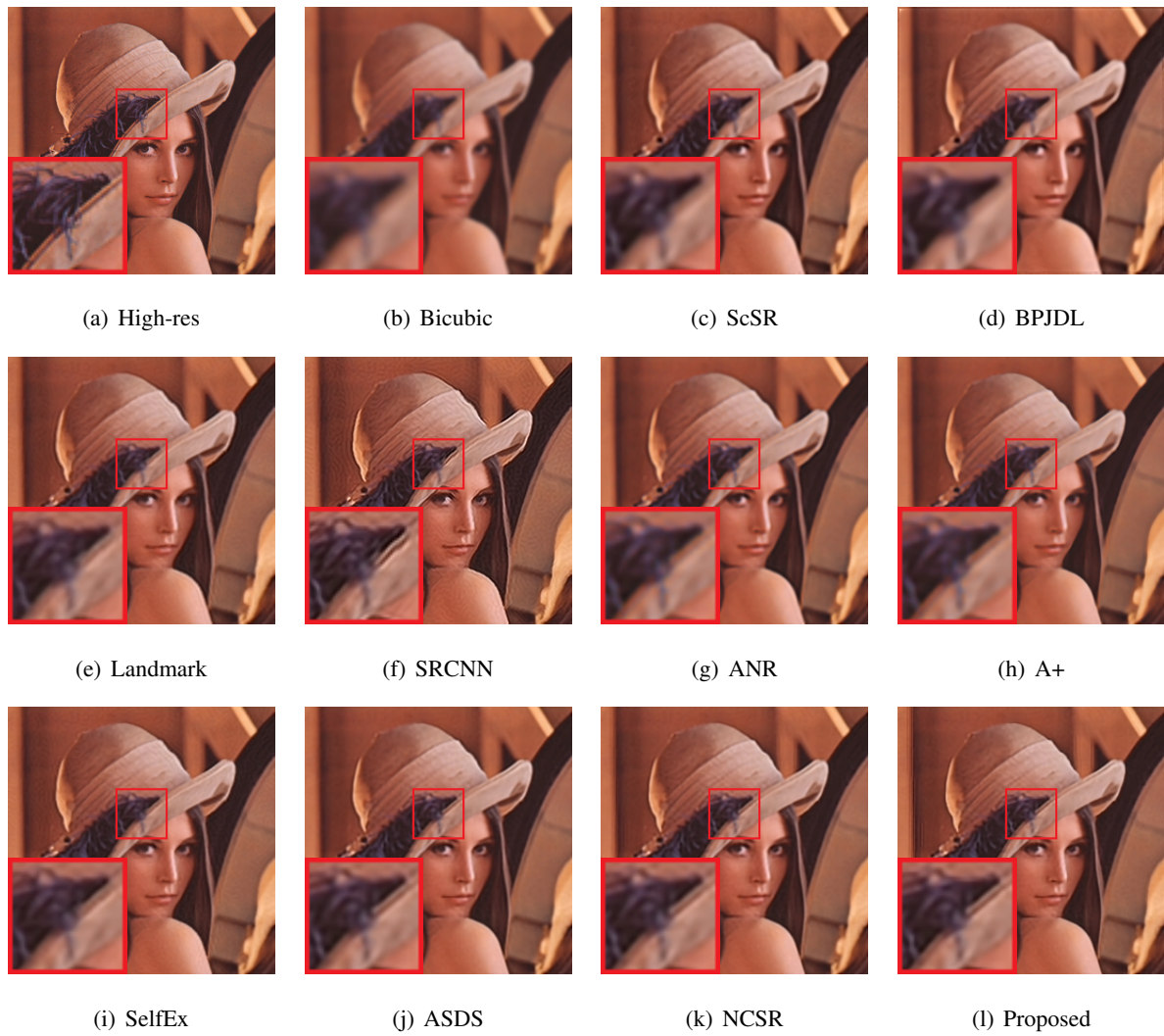


Fig. 42. Visual comparisons between different algorithms for the image *Lena* ($2\times$).

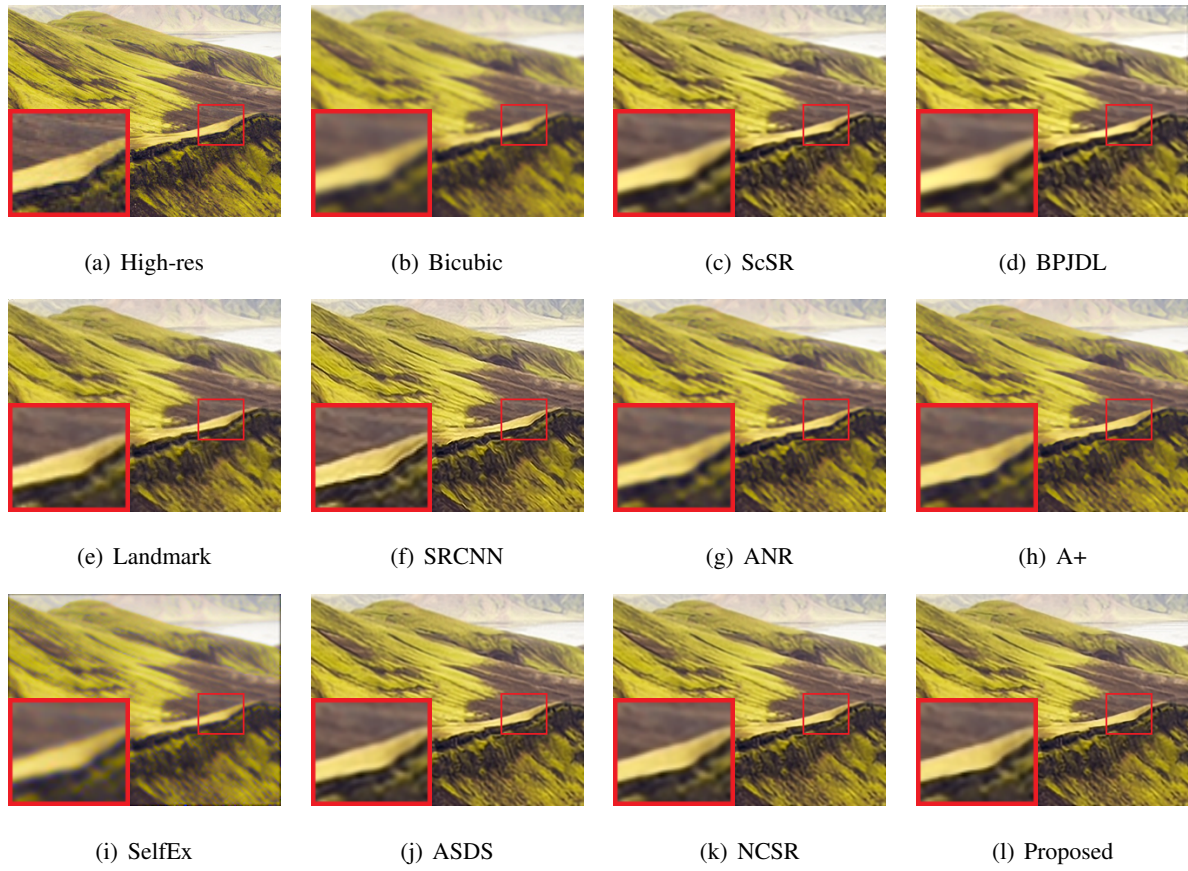


Fig. 43. Visual comparisons between different algorithms for the image *Mountain* ($2\times$).

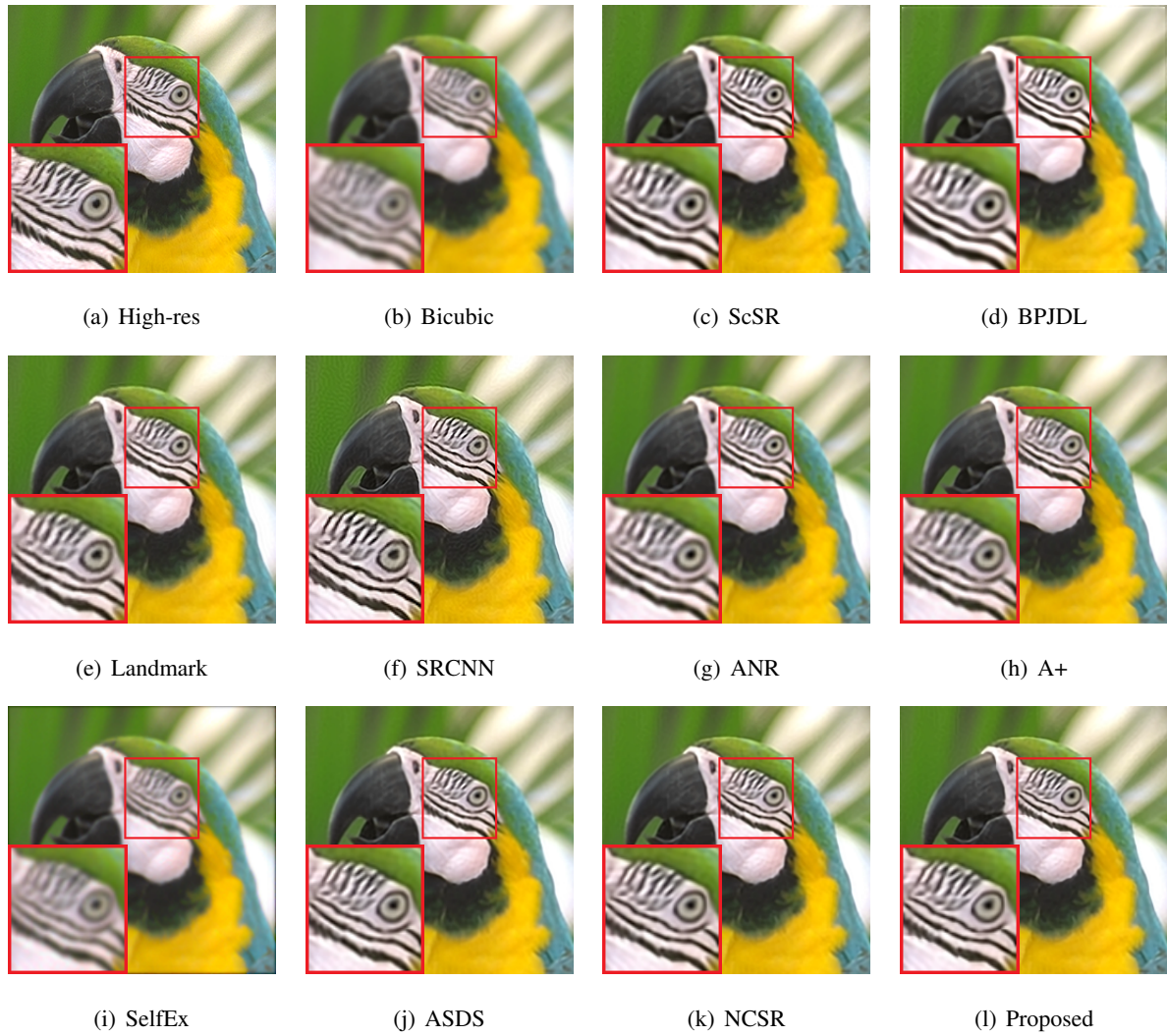


Fig. 44. Visual comparisons between different algorithms for the image *Parrots* ($2\times$).

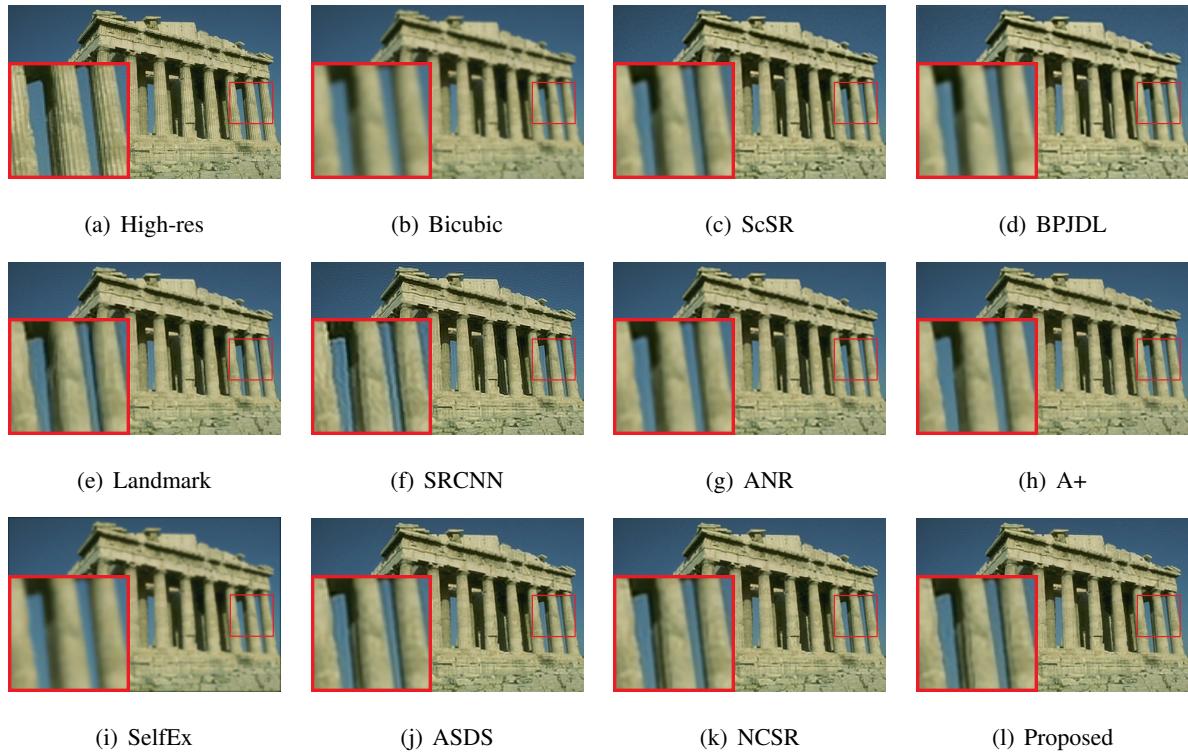


Fig. 45. Visual comparisons between different algorithms for the image *Parthenon* ($2\times$).



Fig. 46. Visual comparisons between different algorithms for the image *Pepper* ($2\times$).



Fig. 47. Visual comparisons between different algorithms for the image *Plants* ($2\times$).

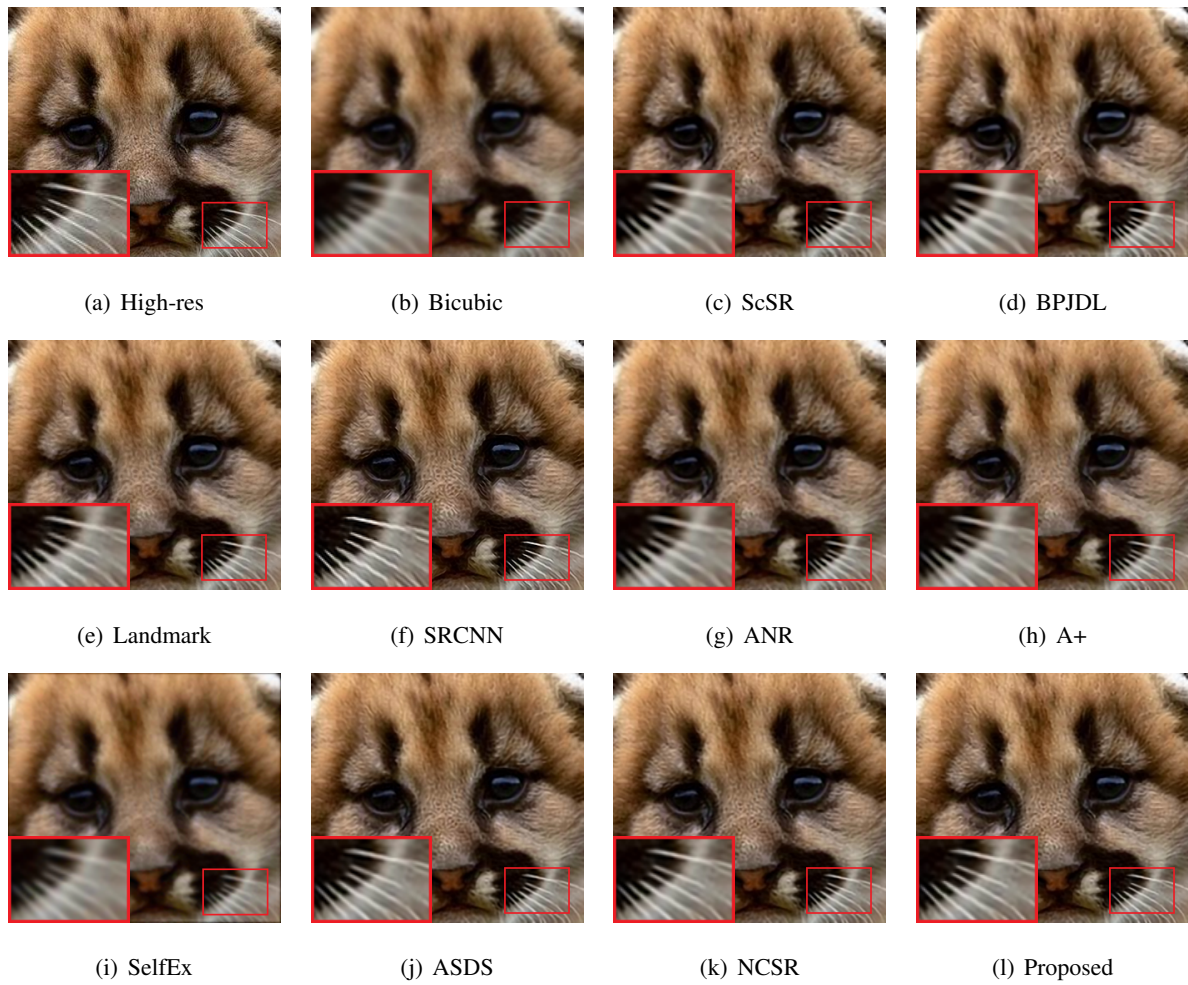


Fig. 48. Visual comparisons between different algorithms for the image *Raccoon* ($2\times$).



Fig. 49. Visual comparisons between different algorithms for the image *Starfish* ($2\times$).

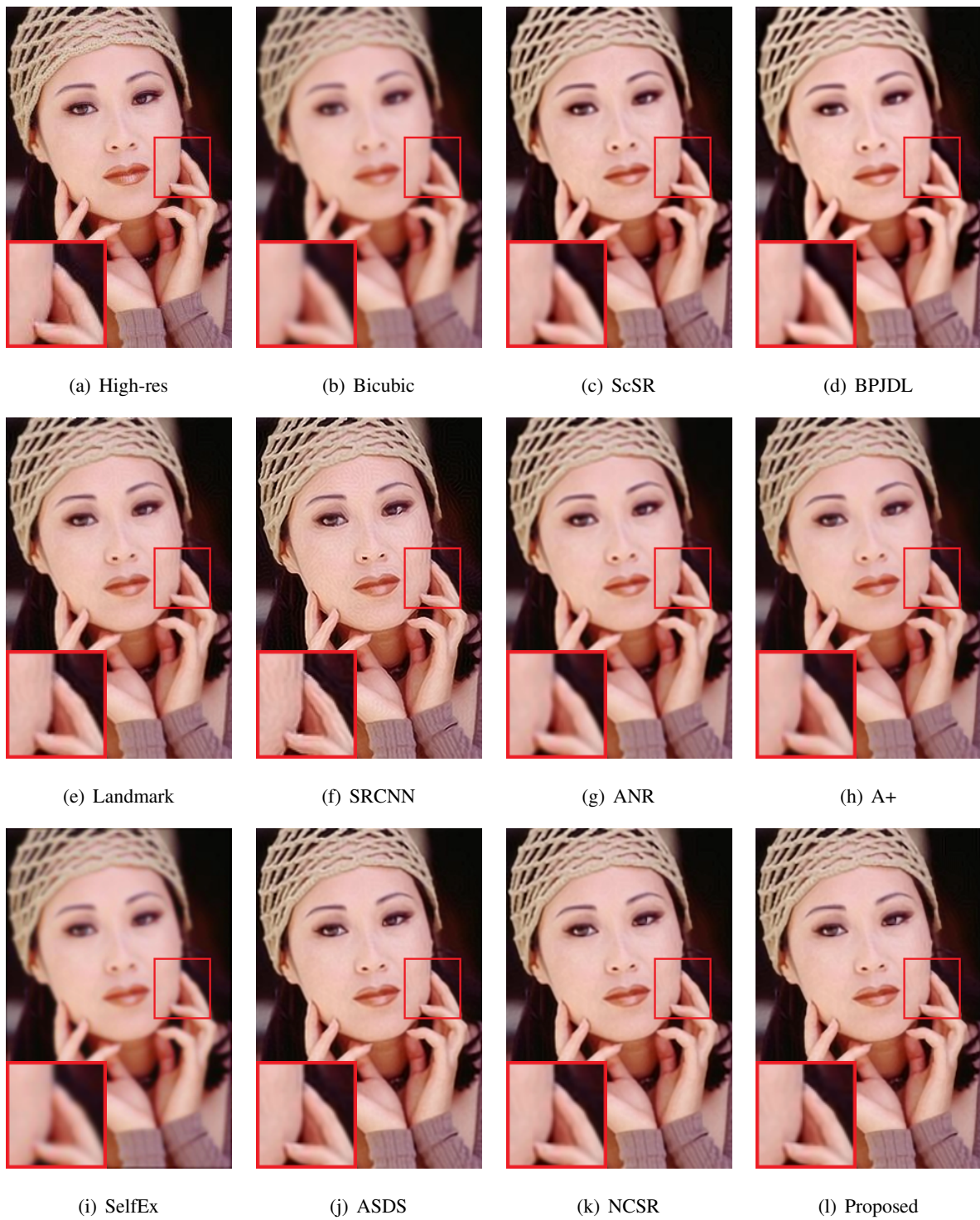


Fig. 50. Visual comparisons between different algorithms for the image *Woman* ($2\times$).

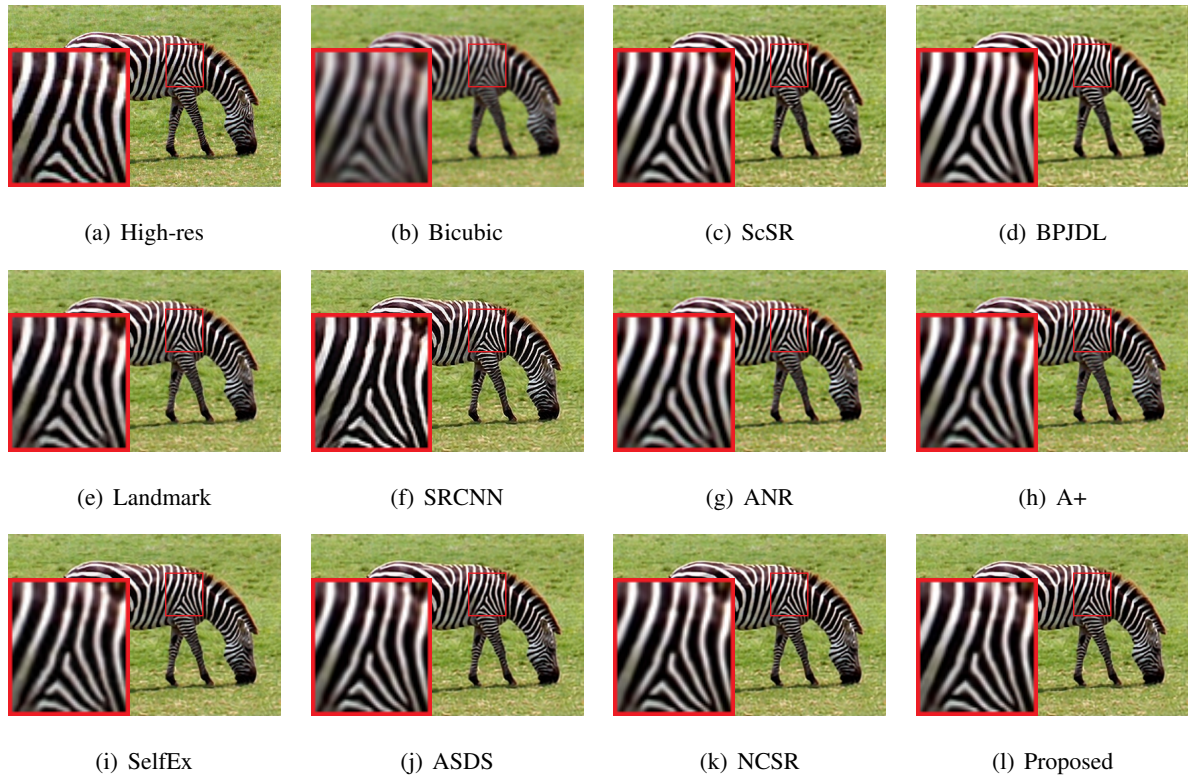


Fig. 51. Visual comparisons between different algorithms for the image *Zebra* ($2\times$).



Fig. 52. Visual comparisons between different algorithms for the image *Text* (2 $\times$).

II. OBJECTIVE RESULTS

TABLE I
PSNR(DB) RESULTS IN $2\times$ ENLARGEMENT.

	Bicubic	ScSR	BPJDL	Landmark	SRCNN	ANR	A+	SelfEx	ASDS	NCSR	Proposed
<i>Baboon</i>	21.23	21.92	21.54	21.91	22.18	21.97	22.08	21.07	22.46	22.48	22.54
<i>Barbara</i>	22.62	23.54	23.18	23.79	23.45	23.23	23.32	23.41	24.07	24.27	24.43
<i>Bike</i>	21.90	24.15	23.22	24.38	26.28	24.75	25.55	23.84	27.03	27.12	27.56
<i>Butterfly</i>	22.42	26.13	24.51	25.60	29.48	27.02	28.49	24.48	29.62	30.71	31.28
<i>Bird</i>	29.94	34.91	32.00	32.88	37.46	35.71	36.59	32.05	38.85	39.11	38.99
<i>Car</i>	26.30	29.60	27.84	28.32	31.85	29.86	30.35	27.84	32.28	32.47	32.78
<i>Field</i>	23.87	25.27	24.39	25.13	26.47	25.56	26.01	24.89	27.02	27.21	27.37
<i>Comic</i>	22.15	24.60	23.35	24.58	26.50	25.11	25.61	23.86	27.24	27.25	27.58
<i>Flower</i>	26.25	28.95	27.38	28.76	30.76	29.61	30.32	27.68	31.46	31.53	31.90
<i>Flowers</i>	23.99	26.34	25.25	26.34	28.20	26.98	27.64	25.67	28.66	28.80	29.12
<i>Foreman</i>	28.21	31.26	29.33	30.60	32.32	31.57	32.12	29.99	33.62	34.01	33.98
<i>Girl</i>	31.50	33.67	32.20	32.93	34.26	34.08	34.26	32.20	34.44	34.59	34.58
<i>Hat</i>	28.30	30.50	29.19	30.41	32.30	31.21	32.01	29.25	32.85	33.05	33.41
<i>House</i>	28.35	31.89	29.69	30.25	32.06	31.41	31.83	29.04	33.31	34.19	34.12
<i>Leaves</i>	21.62	25.84	23.36	22.44	29.76	26.63	27.81	23.05	30.24	31.18	31.73
<i>Lena</i>	28.63	31.46	29.74	30.69	33.12	32.15	32.92	29.28	33.74	33.83	34.02
<i>Mountain</i>	26.15	28.36	27.03	28.40	29.51	28.78	29.17	27.08	30.12	30.22	30.41
<i>Parrots</i>	26.88	30.08	28.08	29.98	31.97	30.64	31.27	28.05	32.53	32.82	33.17
<i>Parthenon</i>	25.26	27.15	26.15	26.66	28.26	27.51	27.95	26.96	28.60	28.79	28.94
<i>Pepper</i>	25.82	28.91	27.34	28.26	30.42	29.14	29.82	27.78	31.05	31.44	32.04
<i>Plants</i>	29.57	32.90	31.08	32.13	35.31	33.77	34.84	31.81	35.81	36.10	36.45
<i>Raccoon</i>	27.50	29.41	28.10	29.30	30.37	29.65	29.94	28.51	31.03	31.07	31.35
<i>Starfish</i>	25.52	28.68	26.70	28.29	31.02	29.15	29.82	24.22	31.78	31.92	32.37
<i>Text</i>	11.74	14.37	13.38	12.23	15.64	14.63	14.99	13.01	12.16	19.70	20.13
<i>Woman</i>	26.62	30.74	28.04	29.89	33.14	31.47	32.31	28.66	33.72	33.97	34.29
<i>Zebra</i>	22.01	25.70	23.50	24.50	28.05	26.22	26.81	23.97	28.40	28.65	29.14
Average	25.17	27.94	26.37	27.26	29.62	28.38	28.99	26.45	30.08	30.63	30.91
Gain	*	2.77	1.20	2.09	4.45	3.21	3.83	1.28	4.91	5.47	5.74

TABLE II
SSIM RESULTS IN $2\times$ ENLARGEMENT.

	Bicubic	ScSR	BPJDL	Landmark	SRCNN	ANR	A+	SelfEx	ASDS	NCSR	Proposed
<i>Baboon</i>	0.4036	0.5357	0.5118	0.5364	0.5598	0.5321	0.5414	0.5037	0.5906	0.5894	0.6020
<i>Barbara</i>	0.6125	0.7019	0.6792	0.7031	0.7246	0.7060	0.7142	0.6764	0.7445	0.7483	0.7594
<i>Bike</i>	0.6478	0.7899	0.7645	0.8041	0.8508	0.8137	0.8400	0.7631	0.8749	0.8781	0.8884
<i>Butterfly</i>	0.7802	0.8792	0.8568	0.8822	0.9231	0.9031	0.9323	0.8430	0.9370	0.9480	0.9523
<i>Bird</i>	0.8905	0.9538	0.9355	0.9441	0.9663	0.9650	0.9702	0.9532	0.9746	0.9756	0.9709
<i>Car</i>	0.8122	0.8979	0.8768	0.8865	0.9249	0.9091	0.9216	0.8661	0.9359	0.9390	0.9384
<i>Field</i>	0.6661	0.7525	0.7316	0.7427	0.7829	0.7656	0.7821	0.7444	0.8143	0.8149	0.8205
<i>Comic</i>	0.6415	0.8023	0.7691	0.8092	0.8551	0.8166	0.8352	0.7656	0.8796	0.8806	0.8910
<i>Flower</i>	0.7421	0.8510	0.8255	0.8541	0.8820	0.8697	0.8863	0.8379	0.9028	0.9047	0.9099
<i>Flowers</i>	0.6917	0.8087	0.7824	0.8143	0.8447	0.8239	0.8402	0.7872	0.8679	0.8702	0.8776
<i>Foreman</i>	0.8805	0.9256	0.9144	0.9219	0.9382	0.9411	0.9498	0.9120	0.9463	0.9510	0.9491
<i>Girl</i>	0.7714	0.8340	0.8186	0.8253	0.8455	0.8445	0.8490	0.8205	0.8477	0.8541	0.8534
<i>Hat</i>	0.8081	0.8648	0.8536	0.8599	0.8850	0.8807	0.8940	0.8644	0.9010	0.9044	0.9075
<i>House</i>	0.8339	0.8819	0.8665	0.8582	0.8917	0.8954	0.9030	0.8752	0.9042	0.9099	0.9112
<i>Leaves</i>	0.7378	0.8902	0.8518	0.8333	0.9438	0.9100	0.9375	0.8676	0.9543	0.9635	0.9674
<i>Lena</i>	0.8121	0.8799	0.8600	0.8744	0.8991	0.8931	0.9041	0.8698	0.9121	0.9132	0.9121
<i>Mountain</i>	0.6618	0.7922	0.7695	0.7976	0.8266	0.8043	0.8153	0.7835	0.8491	0.8515	0.8569
<i>Parrots</i>	0.8588	0.9101	0.8966	0.9102	0.9230	0.9226	0.9300	0.8938	0.9348	0.9366	0.9383
<i>Parthenon</i>	0.6689	0.7626	0.7428	0.7544	0.7920	0.7735	0.7868	0.7520	0.8115	0.8164	0.8213
<i>Pepper</i>	0.8060	0.8772	0.8581	0.8711	0.8977	0.8904	0.9025	0.8560	0.9082	0.9111	0.9157
<i>Plants</i>	0.8353	0.9089	0.8908	0.9058	0.9314	0.9258	0.9390	0.8928	0.9396	0.9450	0.9473
<i>Raccoon</i>	0.6826	0.7908	0.7643	0.7960	0.8225	0.7999	0.8099	0.7798	0.8464	0.8480	0.8553
<i>Starfish</i>	0.7630	0.8728	0.8440	0.8753	0.9059	0.8818	0.8943	0.8502	0.9198	0.9220	0.9273
<i>Text</i>	0.5719	0.7917	0.7584	0.6261	0.8476	0.7952	0.8221	0.7680	0.6035	0.9488	0.9428
<i>Woman</i>	0.8558	0.9266	0.9054	0.9206	0.9411	0.9371	0.9459	0.9021	0.9511	0.9536	0.9541
<i>Zebra</i>	0.6288	0.7980	0.7564	0.7920	0.8404	0.8113	0.8238	0.7496	0.8604	0.8637	0.8706
Average	0.7333	0.8339	0.8109	0.8230	0.8633	0.8466	0.8604	0.8145	0.8697	0.8862	0.8900
Gain	*	0.1006	0.0777	0.0898	0.1300	0.1133	0.1271	0.0813	0.1364	0.1529	0.1568

TABLE III
PSNR(DB) RESULTS IN $3\times$ ENLARGEMENT.

	Bicubic	ScSR	BPJDL	Landmark	SRCNN	ANR	A+	SelfEx	ASDS	NCSR	Proposed
<i>Baboon</i>	20.80	21.50	21.02	21.02	21.66	21.53	21.61	21.10	21.75	21.75	21.75
<i>Barbara</i>	22.04	23.01	22.49	22.55	22.70	22.77	22.84	22.90	23.33	23.37	23.35
<i>Bike</i>	20.80	23.36	21.91	21.68	24.21	23.45	24.18	21.02	24.66	24.72	25.00
<i>Butterfly</i>	20.78	25.14	22.70	21.92	26.52	25.12	26.44	22.64	27.29	28.08	28.83
<i>Bird</i>	27.52	33.33	30.09	28.41	33.75	33.31	34.30	30.75	35.36	35.81	35.99
<i>Car</i>	24.66	28.03	26.17	25.06	28.64	28.11	28.56	24.52	29.36	29.42	29.63
<i>Field</i>	23.01	24.57	23.45	23.25	24.88	24.62	25.05	23.95	25.28	25.40	25.57
<i>Comic</i>	20.87	23.53	21.92	21.59	24.29	23.57	24.02	21.58	24.60	24.65	24.85
<i>Flower</i>	24.83	28.00	25.79	25.67	28.53	28.13	28.73	25.02	29.32	29.50	29.68
<i>Flowers</i>	22.70	25.44	23.83	23.42	26.00	25.63	26.21	23.15	26.52	26.62	26.79
<i>Foreman</i>	26.48	30.34	28.07	27.72	29.87	30.10	30.74	28.48	31.72	32.10	32.04
<i>Girl</i>	29.95	32.91	31.03	30.55	32.99	33.06	33.36	30.94	33.52	33.66	33.63
<i>Hat</i>	27.20	29.86	28.10	27.89	30.50	29.88	30.78	28.55	30.97	31.27	31.59
<i>House</i>	26.62	30.42	28.13	27.46	30.62	30.02	30.56	28.23	31.59	31.41	30.46
<i>Leaves</i>	19.83	24.40	21.27	19.21	26.06	24.35	25.32	21.37	26.76	27.43	28.29
<i>Lena</i>	26.91	30.73	28.49	27.46	31.51	30.82	31.59	28.70	32.05	32.25	32.34
<i>Mountain</i>	25.00	27.40	25.84	25.76	28.23	27.46	27.87	25.95	28.27	28.36	28.39
<i>Parrots</i>	25.58	28.85	26.64	27.00	30.54	29.06	29.74	26.29	30.41	30.49	30.92
<i>Parthenon</i>	24.12	26.35	25.14	24.30	26.69	26.42	26.88	25.10	27.01	27.17	27.33
<i>Pepper</i>	24.07	27.92	25.81	24.90	28.43	27.80	28.55	25.88	29.37	29.62	30.17
<i>Plants</i>	27.83	31.96	29.52	28.69	32.81	31.91	32.93	29.06	33.53	34.04	34.38
<i>Raccoon</i>	26.38	28.50	26.92	27.07	28.66	28.50	28.80	26.85	29.26	29.28	29.37
<i>Starfish</i>	23.86	27.41	25.06	24.69	28.54	27.57	28.14	25.54	29.08	29.25	29.50
<i>Text</i>	10.80	12.82	11.66	10.09	13.44	12.79	13.19	12.03	11.55	14.08	14.52
<i>Woman</i>	24.60	29.54	26.03	26.09	30.45	29.69	30.66	25.97	31.38	31.87	32.24
<i>Zebra</i>	20.43	24.14	21.49	20.88	25.10	24.39	24.97	21.04	25.31	25.52	25.80
Average	23.76	26.90	24.95	24.40	27.52	26.93	27.54	24.87	28.05	28.35	28.55
Gain	*	3.14	1.19	0.64	3.77	3.17	3.78	1.11	4.29	4.59	4.80

TABLE IV
SSIM RESULTS IN $3 \times$ ENLARGEMENT.

	Bicubic	ScSR	BPJDL	Landmark	SRCNN	ANR	A+	SelfEx	ASDS	NCSR	Proposed
<i>Baboon</i>	0.3547	0.4714	0.4234	0.4125	0.4924	0.4684	0.4850	0.4199	0.5042	0.5068	0.5070
<i>Barbara</i>	0.5659	0.6608	0.6141	0.6090	0.6383	0.6593	0.6716	0.6276	0.6809	0.6850	0.6864
<i>Bike</i>	0.5759	0.7400	0.6680	0.6679	0.7736	0.7446	0.7811	0.6577	0.7983	0.8027	0.8139
<i>Butterfly</i>	0.7175	0.8543	0.7887	0.7925	0.8664	0.8547	0.8989	0.7541	0.9034	0.9157	0.9298
<i>Bird</i>	0.8363	0.9351	0.8919	0.8754	0.9363	0.9395	0.9501	0.8995	0.9534	0.9570	0.9570
<i>Car</i>	0.7557	0.8595	0.8126	0.7902	0.8655	0.8622	0.8826	0.8036	0.8882	0.8915	0.8919
<i>Field</i>	0.6248	0.7072	0.6662	0.6390	0.7134	0.7091	0.7321	0.6748	0.7368	0.7413	0.7390
<i>Comic</i>	0.5573	0.7371	0.6607	0.6455	0.7684	0.7374	0.7653	0.6254	0.7869	0.7908	0.8011
<i>Flower</i>	0.6753	0.8124	0.7476	0.7511	0.8178	0.8178	0.8413	0.7593	0.8499	0.8564	0.8608
<i>Flowers</i>	0.6276	0.7620	0.7006	0.7008	0.7633	0.7634	0.7857	0.7098	0.7985	0.8028	0.8092
<i>Foreman</i>	0.8491	0.9151	0.8831	0.8820	0.9295	0.9182	0.9330	0.8666	0.9332	0.9358	0.9383
<i>Girl</i>	0.7334	0.8066	0.7713	0.7641	0.8062	0.8113	0.8210	0.7705	0.8204	0.8276	0.8246
<i>Hat</i>	0.7778	0.8449	0.8132	0.7946	0.8515	0.8463	0.8671	0.8267	0.8650	0.8705	0.8770
<i>House</i>	0.7952	0.8640	0.8300	0.8032	0.8580	0.8667	0.8816	0.8267	0.8793	0.8801	0.8790
<i>Leaves</i>	0.6411	0.8482	0.7523	0.6543	0.8754	0.8458	0.8897	0.7599	0.9066	0.9215	0.9380
<i>Lena</i>	0.7660	0.8563	0.8133	0.7999	0.8675	0.8603	0.8763	0.8007	0.8806	0.8844	0.8844
<i>Mountain</i>	0.6041	0.7342	0.6846	0.6670	0.7345	0.7360	0.7557	0.6973	0.7725	0.7767	0.7746
<i>Parrots</i>	0.8261	0.8943	0.8637	0.8657	0.9011	0.8983	0.9105	0.8759	0.9140	0.9147	0.9197
<i>Parthenon</i>	0.6205	0.7199	0.6787	0.6468	0.7190	0.7184	0.7395	0.6435	0.7434	0.7506	0.7566
<i>Pepper</i>	0.7532	0.8541	0.8066	0.7973	0.8603	0.8574	0.8767	0.8151	0.8798	0.8833	0.8917
<i>Plants</i>	0.7875	0.8855	0.8420	0.8361	0.8924	0.8909	0.9117	0.8311	0.9086	0.9190	0.9252
<i>Raccoon</i>	0.6280	0.7334	0.6806	0.6837	0.7289	0.7350	0.7504	0.6915	0.7673	0.7709	0.7697
<i>Starfish</i>	0.6942	0.8299	0.7678	0.7719	0.8501	0.8328	0.8514	0.7369	0.8693	0.8727	0.8786
<i>Text</i>	0.4786	0.7000	0.6259	0.3840	0.7275	0.6824	0.7264	0.5913	0.5975	0.7718	0.8069
<i>Woman</i>	0.8061	0.9050	0.8566	0.8595	0.9121	0.9077	0.9235	0.8580	0.9263	0.9307	0.9355
<i>Zebra</i>	0.5398	0.7264	0.6390	0.6233	0.7566	0.7310	0.7517	0.7565	0.7656	0.7722	0.7748
Average	0.6766	0.7945	0.7416	0.7199	0.8041	0.7960	0.8177	0.7415	0.8204	0.8320	0.8373
Gain	*	0.1179	0.0650	0.0433	0.1275	0.1194	0.1411	0.0649	0.1438	0.1554	0.1607