Supplemental instrument

Tri-modal medical image fusion and denoising based on bitonicX filtering

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Noise-free fusion results

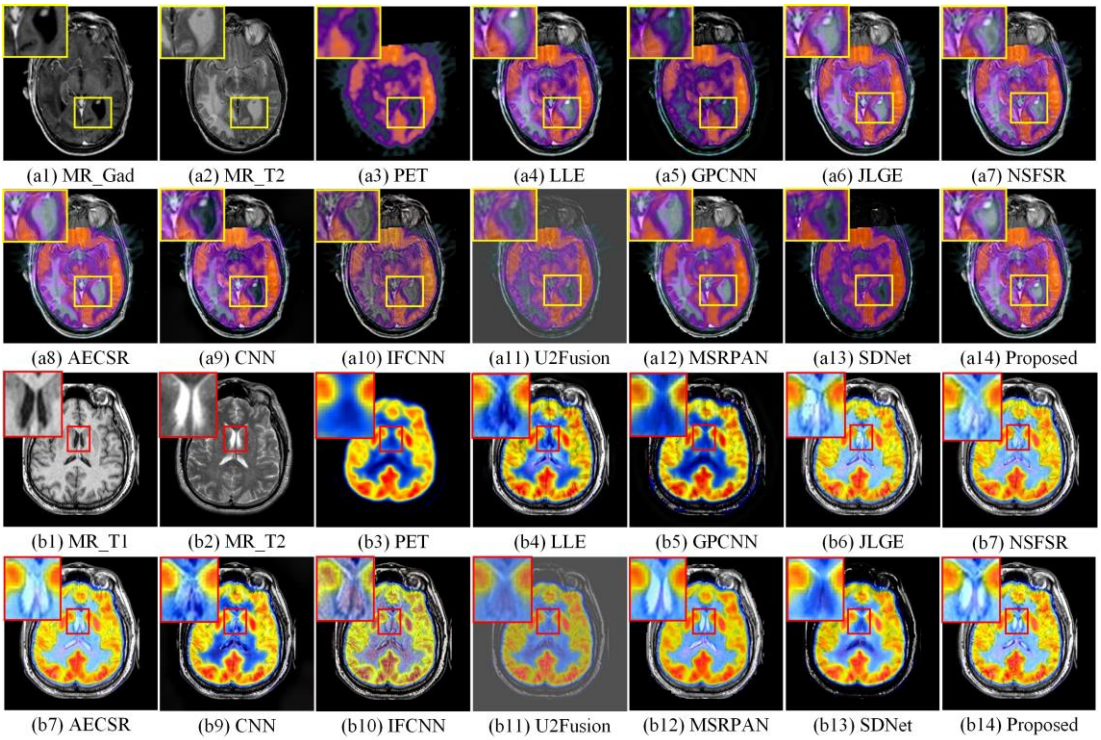

Fig.1. Fusion result of MR_Gad-MR_T2-PET, and MR_Gad-MR_T2-PET images.

Table 1. Objective evaluation of five different types of fused images without noise. (red: the best; blue: suboptimal)

Images	Methods	Q_{MI}	Q_{TE}	Q_{NCIE}	Q_P	Q_{CB}	Q_{SSIM}	PSNR	CNR	CC
CT/MR_T2 /SPECT	LLE	0.7516	0.3950	0.8110	0.4122	0.6869	0.5066	13.1516	1.4185	0.7156
	GPCNN	0.6372	0.3757	0.8083	0.1923	0.5865	0.5029	15.0755	1.9206	0.7233
	JLGE	0.8854	0.3982	0.8122	0.5298	0.7210	0.5889	12.8788	1.8185	0.7343
	NSFSR	0.8329	0.3907	0.8112	0.4908	0.7234	0.5963	13.0114	1.7050	0.7333
	AECSR	0.8459	0.3955	0.8111	0.4748	0.7046	0.5969	12.5820	1.8369	0.7323
	CNN	0.7071	0.4381	0.8103	0.4254	0.5441	0.4907	13.1827	1.4024	0.7230
	IFCNN	0.7494	0.3453	0.8087	0.4531	0.7331	0.6104	14.6648	1.9997	0.7603
	U2Fusion	0.7112	0.5226	0.8084	0.3375	0.3614	0.2014	15.7540	2.1696	0.7764
	MSRPAN	0.9249	0.3805	0.8111	0.4170	0.6755	0.6171	13.2393	2.1387	0.7209
	SDNet	0.7662	0.4327	0.8091	0.3668	0.6924	0.3309	15.1541	2.3385	0.7659
	Proposed	1.0296	0.4113	0.8159	0.5543	0.7306	0.5968	12.6154	1.8669	0.7310
MR_T1/ MR_T2/PET	LLE	0.6940	0.3663	0.8094	0.4150	0.6412	0.4263	11.3889	2.0807	0.6152
	GPCNN	0.6152	0.3749	0.8072	0.2413	0.5536	0.3955	11.8648	1.1134	0.5806
	JLGE	0.8503	0.3814	0.8128	0.4603	0.6674	0.4371	11.0995	2.2783	0.6412
	NSFSR	0.8001	0.3764	0.8113	0.4549	0.6650	0.4380	11.1842	2.2812	0.6438
	AECSR	0.8099	0.3779	0.8116	0.3841	0.6553	0.4382	11.0685	2.2993	0.6498
	CNN	0.5970	0.3796	0.8077	0.4095	0.5374	0.3702	11.3949	1.8939	0.6007
	IFCNN	0.6835	0.3392	0.8074	0.3877	0.6602	0.4437	11.8750	2.0360	0.6282
	U2Fusion	0.7275	0.5646	0.8080	0.3477	0.3360	0.0890	12.6233	1.1392	0.5633
	MSRPAN	0.8725	0.3579	0.8108	0.3846	0.6388	0.4521	11.6381	2.3480	0.6492
	SDNet	0.6842	0.4055	0.8068	0.2609	0.6082	0.2059	12.1141	1.2370	0.5697
	Proposed	0.9617	0.3937	0.8163	0.4760	0.6655	0.4405	11.0214	2.3142	0.6469
MR_T1/ MR_T2/SPECT	LLE	0.6732	0.3896	0.8104	0.4751	0.6418	0.3508	11.4580	2.1308	0.5940
	GPCNN	0.8412	0.4187	0.8150	0.6373	0.6191	0.3395	13.0801	2.2181	0.5893
	JLGE	0.8666	0.4224	0.8161	0.6679	0.6551	0.3458	10.9933	2.6312	0.6387
	NSFSR	0.8259	0.4174	0.8147	0.6486	0.6370	0.3471	11.0807	2.6418	0.6374
	AECSR	0.8412	0.4187	0.8150	0.6373	0.6191	0.3493	10.8976	2.6733	0.6508
	CNN	0.6568	0.3982	0.8104	0.5048	0.5822	0.3128	11.4242	2.5291	0.6247
	IFCNN	0.6650	0.3528	0.8087	0.4898	0.6096	0.3637	12.5578	2.4184	0.6275
	U2Fusion	0.6385	0.5090	0.8080	0.3405	0.3935	0.0942	13.4888	2.2299	0.6517
	MSRPAN	0.7875	0.3792	0.8131	0.5260	0.5783	0.3725	11.7072	2.6258	0.6348
	SDNet	0.6529	0.4065	0.8081	0.3027	0.6034	0.1867	12.5879	2.3286	0.6487
	Proposed	1.1161	0.4442	0.8267	0.7258	0.6532	0.4405	11.0214	2.3142	0.6469
MR_T2/ MR_Gad/PET	LLE	0.6408	0.3639	0.8080	0.3119	0.6293	0.4618	15.3162	2.8294	0.7033
	GPCNN	0.6206	0.3579	0.8076	0.2471	0.5796	0.4559	16.4039	3.0677	0.6773

	JLGE	0.7984	0.3836	0.8111	0.4008	0.6527	0.4635	14.9399	2.9898	0.7183
	NSFSR	0.7281	0.3763	0.8095	0.4008	0.6526	0.4650	15.0070	3.0404	0.7200
	AECSR	0.7587	0.3824	0.8099	0.3733	0.6301	0.4678	14.7627	3.0570	0.7254
	CNN	0.5846	0.3650	0.8077	0.3376	0.5506	0.4287	15.3929	2.8126	0.6915
	IFCNN	0.6654	0.3418	0.8075	0.3722	0.6678	0.4771	16.2171	3.0002	0.7106
	U2Fusion	0.6550	0.5366	0.8074	0.3193	0.3720	0.1412	16.7360	1.5634	0.6492
	MSRPAN	0.8901	0.3814	0.8113	0.3847	0.6244	0.4797	15.6996	3.0651	0.7162
	SDNet	0.7153	0.4256	0.8080	0.3697	0.6260	0.2644	16.8810	2.1506	0.6837
	Proposed	0.9722	0.3981	0.8150	0.4514	0.6623	0.4662	14.7662	3.0127	0.7228
MR_T2/ MR_Gad/SPECT	LLE	0.7100	0.3682	0.8081	0.4477	0.6229	0.4894	13.0170	1.7032	0.6026
	GPCNN	0.5724	0.3496	0.8060	0.1711	0.5509	0.4668	13.9668	0.4376	0.5409
	JLGE	0.8649	0.3895	0.8111	0.6030	0.6330	0.4937	12.6547	1.9599	0.6373
	NSFSR	0.7981	0.3805	0.8095	0.5414	0.6271	0.4939	12.6572	1.9006	0.6332
	AECSR	0.8260	0.3853	0.8101	0.5506	0.6102	0.4956	12.5953	2.0619	0.6451
	CNN	0.6807	0.3952	0.8080	0.4670	0.5432	0.4373	12.8496	1.7264	0.6236
	IFCNN	0.6529	0.3522	0.8071	0.4532	0.6059	0.4971	13.7332	1.4925	0.6115
	U2Fusion	0.7129	0.5560	0.8071	0.3666	0.3012	0.0958	14.3492	1.6544	0.6301
	MSRPAN	0.8610	0.3597	0.8095	0.4537	0.5985	0.5050	13.2923	2.0736	0.6370
	SDNet	0.7002	0.4298	0.8063	0.3070	0.6087	0.2232	13.9088	1.6939	0.6248
	Proposed	1.0690	0.4013	0.8165	0.6466	0.6232	0.4941	12.6113	2.0007	0.6385

Noise-containing fusion results

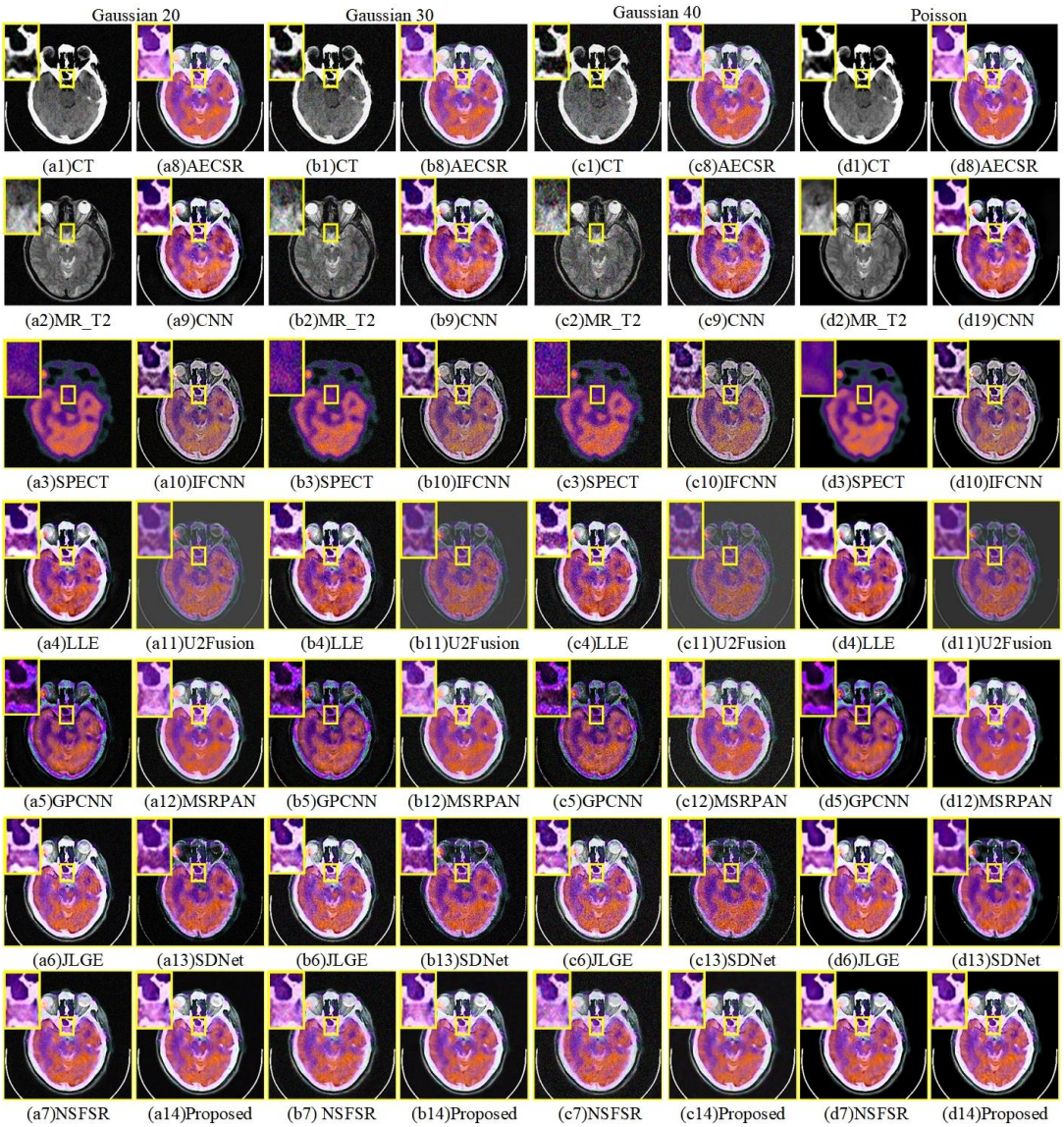

Fig.2. Fusion result of CT-MR_T2-SPECT images with different levels of noise.

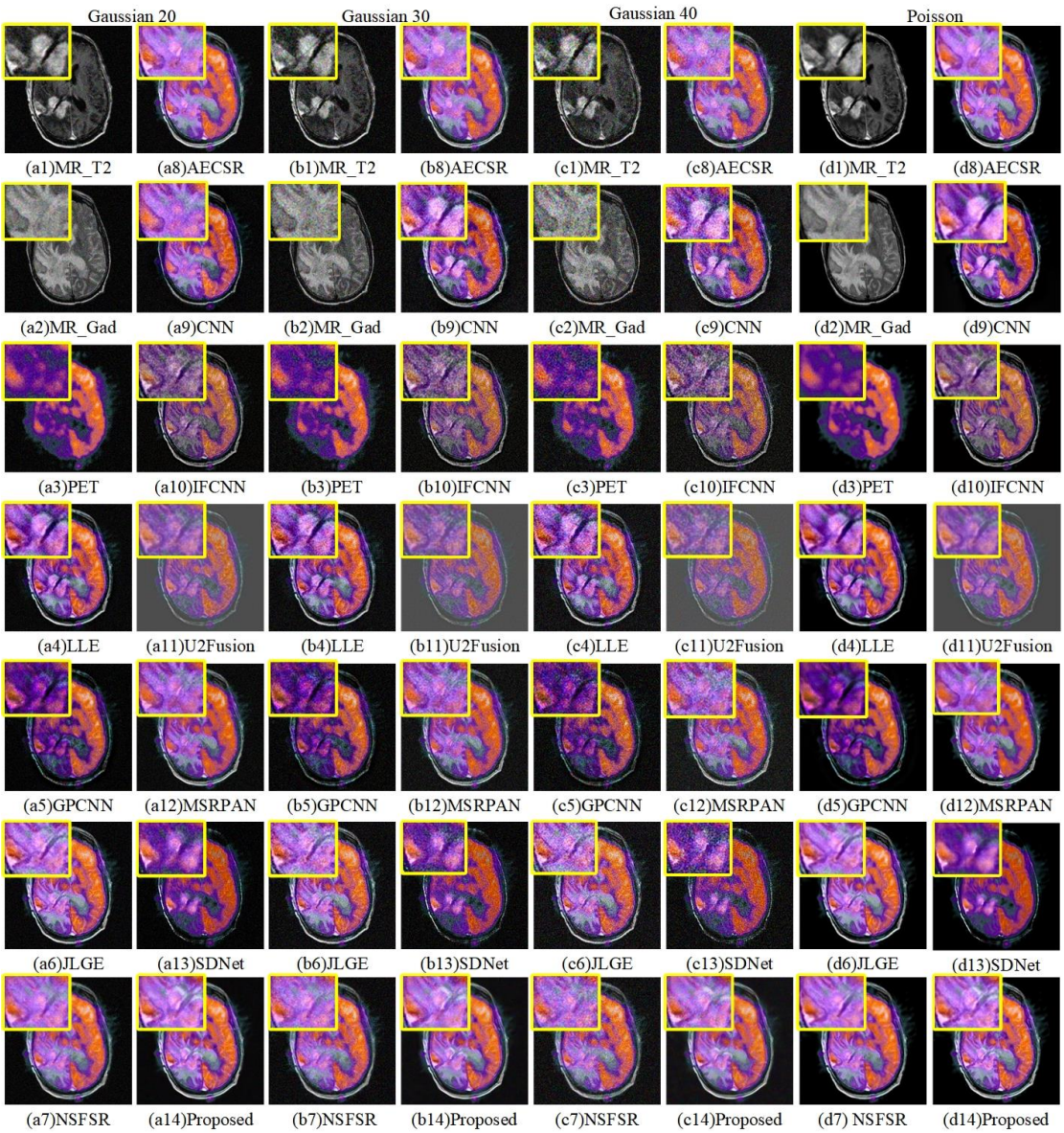

Fig.3. Fusion result of MR_T2-MR_Gad-PET images with different levels of noise.

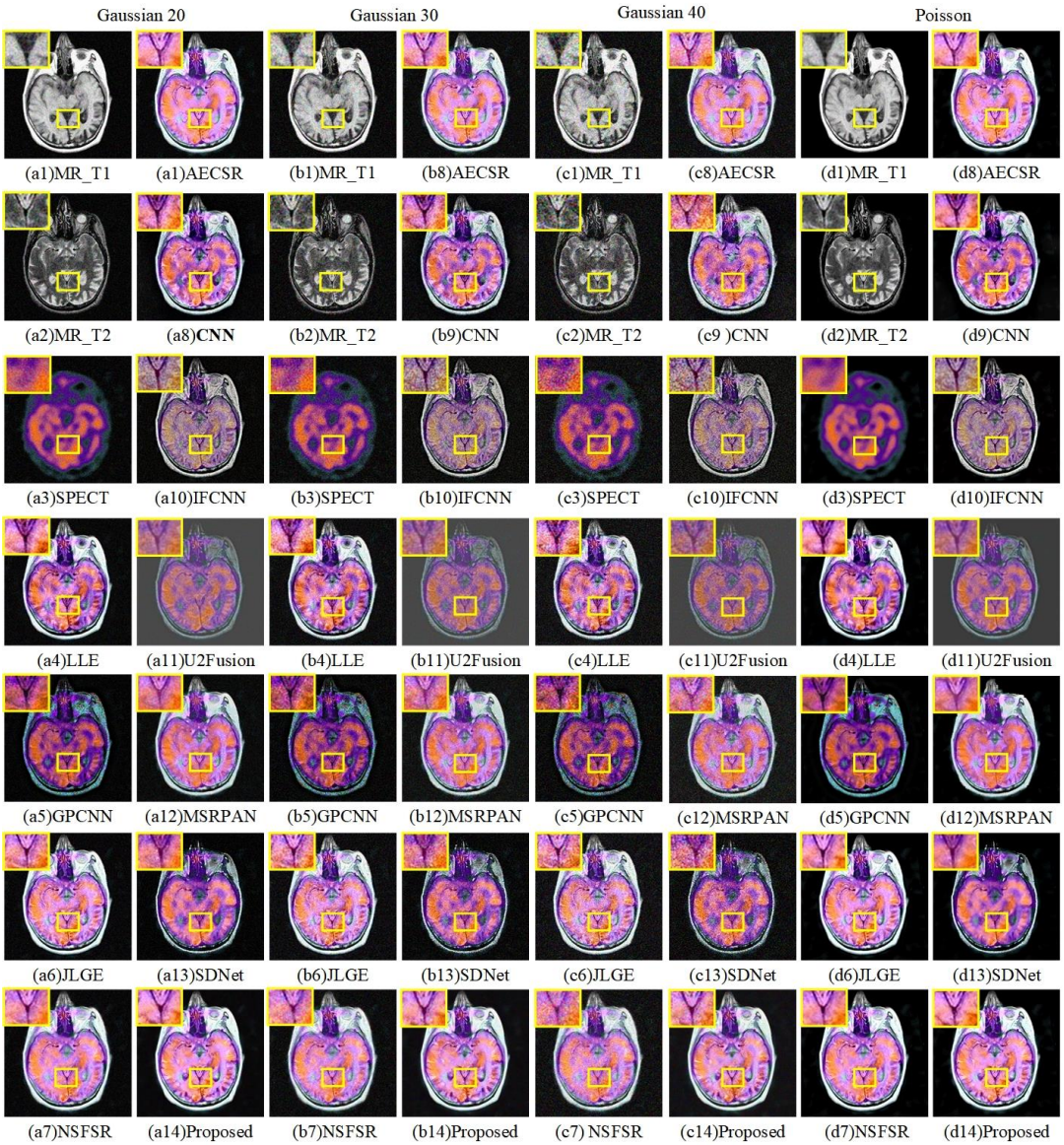

Fig.4. Fusion result of MR_T2-MR_T2-SPECT images with different levels of noise.

Table 2. Objective evaluation of five different types of fused images Gaussian noise 20. (red: the best; blue: suboptimal)

Images	Methods	Q_{MI}	Q_{TE}	Q_{NCIE}	Q_P	Q_{CB}	Q_{SSIM}	PSNR	CNR	CC
CT/MR_T2 /SPECT	LLE	0.5288	0.3958	0.8087	0.3185	0.5165	0.1506	13.0998	1.2816	0.7034
	GPCNN	0.4434	0.3382	0.8064	0.1241	0.4539	0.1682	15.1711	2.1848	0.7306
	JLGE	0.7582	0.4622	0.8171	0.4285	0.4795	0.1587	12.8782	1.7019	0.7248
	NSFSR	0.5577	0.4227	0.8093	0.3020	0.4359	0.1791	13.1977	1.7354	0.7363
	AECSR	0.5647	0.4200	0.8092	0.3427	0.4517	0.1756	12.5963	1.7492	0.7250
	CNN	0.6250	0.4180	0.8110	0.3363	0.4944	0.1682	13.0560	1.4363	0.7201
	IFCNN	0.5278	0.3765	0.8085	0.3157	0.4789	0.1725	13.8407	1.5391	0.7158
	U2Fusion	0.5070	0.4457	0.8068	0.2177	0.3708	0.1612	15.5970	2.1263	0.7684
	MSRPAN	0.4484	0.3789	0.8070	0.0557	0.3708	0.1396	12.6478	2.0780	0.6838
	SDNet	0.4844	0.3853	0.8069	0.1728	0.4688	0.1528	14.8818	2.1489	0.7496
	Proposed	0.8366	0.4781	0.8152	0.5255	0.4417	0.2403	12.7575	1.7909	0.7266
MR_T1/ MR_T2/PET	LLE	0.4827	0.4033	0.8075	0.3659	0.4288	0.0755	11.3742	1.8863	0.6017
	GPCNN	0.4425	0.3307	0.8057	0.1743	0.4392	0.1073	11.9885	1.0949	0.5694
	JLGE	0.6987	0.4664	0.8159	0.4320	0.4147	0.0795	11.1171	2.1183	0.6321
	NSFSR	0.5534	0.4410	0.8096	0.3977	0.3906	0.0912	11.3271	2.2522	0.6438
	AECSR	0.5881	0.4330	0.8107	0.3750	0.4027	0.0885	11.0307	2.2587	0.6459
	CNN	0.4903	0.3829	0.8075	0.3786	0.4266	0.0918	11.3304	1.8540	0.5914
	IFCNN	0.4813	0.3822	0.8072	0.3274	0.4269	0.0820	11.9534	1.5060	0.5918
	U2Fusion	0.5061	0.4645	0.8064	0.2797	0.3488	0.0760	12.5506	1.0803	0.5583

	MSRPAN	0.3518	0.3761	0.8051	0.0170	0.3257	0.0559	11.2479	2.0091	0.5772
	SDNet	0.4181	0.3721	0.8053	0.1751	0.4187	0.0728	12.0520	1.0557	0.5567
	Proposed	0.7882	0.4870	0.8156	0.4422	0.3795	0.1381	11.1412	2.2375	0.6442
MR_T1/ MR_T2/SPECT	LLE	0.4984	0.3930	0.8087	0.4138	0.4978	0.0683	11.4327	1.9415	0.5799
	GPCNN	0.4081	0.3243	0.8058	0.1438	0.4737	0.1127	13.2885	2.0134	0.6026
	JLGE	0.7928	0.4606	0.8227	0.5521	0.4990	0.0707	10.9960	2.5017	0.6293
	NSFSR	0.5552	0.4234	0.8103	0.4327	0.4398	0.0891	11.3138	2.6902	0.6432
	AECSR	0.6454	0.4263	0.8141	0.4916	0.4668	0.0822	10.9170	2.5730	0.6449
	CNN	0.5826	0.4086	0.8113	0.4347	0.4993	0.0831	11.2845	2.4771	0.6218
	IFCNN	0.4809	0.3640	0.8079	0.3645	0.4723	0.0768	11.8795	2.2897	0.6234
	U2Fusion	0.4654	0.4328	0.8064	0.2539	0.3984	0.0803	13.4530	2.1835	0.6468
	MSRPAN	0.3700	0.3664	0.8056	0.0474	0.3636	0.0624	11.3662	2.5319	0.6174
	SDNet	0.4274	0.3589	0.8060	0.1674	0.4647	0.0687	12.5321	2.2116	0.6388
	Proposed	0.9067	0.4890	0.8227	0.6477	0.4571	0.1334	11.0554	2.6371	0.6390
MR_T2/ MR_Gad/PET	LLE	0.4640	0.3727	0.8070	0.2141	0.4515	0.1036	15.0069	2.5581	0.6787
	GPCNN	0.4189	0.3015	0.8056	0.1250	0.4513	0.1344	16.2347	2.7204	0.6489
	JLGE	0.6561	0.4180	0.8133	0.2582	0.4475	0.1078	14.7071	2.7868	0.6994
	NSFSR	0.4694	0.3877	0.8070	0.2088	0.4063	0.1270	15.1258	3.0213	0.7198
	AECSR	0.4939	0.3793	0.8076	0.2081	0.4150	0.1208	14.6164	2.9077	0.7128
	CNN	0.4424	0.3722	0.8064	0.1841	0.4490	0.0974	15.4409	2.8092	0.6767
	IFCNN	0.4499	0.3506	0.8065	0.2022	0.4467	0.1124	16.0074	1.5995	0.6548
	U2Fusion	0.4563	0.4367	0.8058	0.1866	0.3776	0.1139	16.5328	1.3414	0.6305
	MSRPAN	0.3582	0.3361	0.8052	0.0205	0.3494	0.0953	15.3294	2.1876	0.6623
	SDNet	0.4188	0.3401	0.8054	0.1218	0.4447	0.1031	16.5144	1.8462	0.6572
	Proposed	0.7549	0.4783	0.8130	0.3486	0.4046	0.1769	14.7419	2.9129	0.7139
MR_T2/ MR_Gad/SPECT	LLE	0.4686	0.4009	0.8072	0.3790	0.4013	0.0712	12.9277	1.4573	0.5827
	GPCNN	0.3541	0.2970	0.8045	0.1329	0.4128	0.1177	14.0404	0.0169	0.5298
	JLGE	0.7104	0.4633	0.8165	0.4678	0.3946	0.0768	12.5994	1.7849	0.6237
	NSFSR	0.5132	0.4260	0.8081	0.4167	0.3696	0.1013	12.8767	1.8357	0.6333
	AECSR	0.5462	0.4168	0.8092	0.3992	0.3635	0.0878	12.5752	1.9132	0.6360
	CNN	0.5498	0.4183	0.8093	0.3975	0.4099	0.0770	12.7042	1.6266	0.6119
	IFCNN	0.4607	0.3696	0.8068	0.3435	0.3917	0.0794	13.1543	1.5871	0.6132
	U2Fusion	0.4683	0.4528	0.8057	0.2773	0.3146	0.0767	14.2985	1.6156	0.6251
	MSRPAN	0.3438	0.3750	0.8047	0.0483	0.3016	0.0634	12.6673	1.8731	0.5942
	SDNet	0.3854	0.3595	0.8047	0.1597	0.4018	0.0697	13.7883	1.5872	0.6141
	Proposed	0.8128	0.4899	0.8153	0.5406	0.3441	0.1466	12.7128	1.9386	0.6332

Table 3. Objective evaluation of five different types of fused images Gaussian noise 30. (red: the best; blue: suboptimal)

Images	**Methods**	**Q_{MI}**	**Q_{TE}**	**Q_{NCIE}**	**Q_{P}**	**Q_{CB}**	**Q_{SSIM}**	**PSNR**	**CNR**	**CC**
CT/MR_T2 /SPECT	LLE	0.5063	0.3963	0.8086	0.2976	0.4930	0.1088	12.9240	1.0939	0.6895
	GPCNN	0.3956	0.3265	0.8058	0.0984	0.4425	0.1023	14.9495	2.0459	0.7120
	JLGE	0.7308	0.4584	0.8175	0.3683	0.4732	0.1158	12.8131	1.5889	0.7161
	NSFSR	0.5097	0.4132	0.8085	0.2353	0.4156	0.1316	13.2237	1.6905	0.7343
	AECSR	0.5088	0.4066	0.8084	0.2711	0.4361	0.1271	12.5686	1.6566	0.7183
	CNN	0.5820	0.4153	0.8105	0.2775	0.4798	0.1168	12.9803	1.4159	0.7080
	IFCNN	0.4824	0.3769	0.8077	0.2715	0.4576	0.1725	13.8407	1.5391	0.7158
	U2Fusion	0.4740	0.4359	0.8065	0.1737	0.3725	0.1612	15.5970	2.1263	0.7684
	MSRPAN	0.4365	0.3760	0.8068	0.0518	0.3698	0.1283	12.6145	2.0504	0.6820
	SDNet	0.4254	0.3690	0.8062	0.1262	0.4436	0.1112	14.5016	1.9570	0.7283
	Proposed	0.8337	0.4831	0.8161	0.4912	0.4102	0.1846	12.8165	1.7532	0.7230
MR_T1/ MR_T2/PET	LLE	0.4541	0.4031	0.8071	0.3244	0.4208	0.0539	11.3016	1.7423	0.5911
	GPCNN	0.4032	0.3268	0.8052	0.1454	0.4353	0.0590	11.9850	0.9840	0.5613
	JLGE	0.6712	0.4653	0.8157	0.3914	0.4064	0.0559	11.0859	2.0293	0.6251
	NSFSR	0.4924	0.4333	0.8082	0.3418	0.3804	0.0642	11.3816	2.2222	0.6431
	AECSR	0.5342	0.4259	0.8096	0.3362	0.3917	0.0613	11.0240	2.1793	0.6412
	CNN	0.4648	0.3901	0.8074	0.3310	0.4205	0.0580	11.2638	1.8181	0.5822
	IFCNN	0.4448	0.3830	0.8067	0.2876	0.4213	0.0557	11.8688	1.3315	0.5786
	U2Fusion	0.4632	0.4458	0.8059	0.2442	0.3582	0.0667	12.5162	1.0400	0.5539
	MSRPAN	0.3302	0.3747	0.8049	0.0161	0.3229	0.0378	11.1681	1.8753	0.5690
	SDNet	0.3771	0.3560	0.8049	0.1401	0.4144	0.0519	11.9365	0.8674	0.5430
	Proposed	0.7646	0.4934	0.8154	0.4242	0.3645	0.0932	11.2136	2.1959	0.6438
MR_T1/ MR_T2/SPECT	LLE	0.4713	0.3893	0.8083	0.3670	0.4910	0.0479	11.3540	1.7862	0.5695
	GPCNN	0.3644	0.3142	0.8052	0.1156	0.4653	0.0665	13.1869	1.7908	0.5864
	JLGE	0.7576	0.4554	0.8221	0.4771	0.4925	0.0484	10.9600	2.4071	0.6217
	NSFSR	0.4904	0.4105	0.8087	0.3272	0.4188	0.0622	11.4081	2.6994	0.6453
	AECSR	0.5407	0.4091	0.8105	0.3747	0.4471	0.0566	10.9255	2.5143	0.6416
	CNN	0.5575	0.4098	0.8111	0.3693	0.4853	0.0521	11.2197	2.4947	0.6147
	IFCNN	0.4450	0.3605	0.8074	0.3076	0.4654	0.0510	11.8258	2.1573	0.6125
	U2Fusion	0.4313	0.4193	0.8060	0.2189	0.4058	0.0698	13.3991	2.1312	0.6400
	MSRPAN	0.3461	0.3601	0.8054	0.0423	0.3633	0.0419	11.3006	2.4344	0.6115
	SDNet	0.3845	0.3397	0.8055	0.1319	0.4547	0.0474	12.3940	2.0460	0.6235
	Proposed	0.8720	0.4929	0.8218	0.6264	0.4414	0.0949	11.1329	2.6226	0.6385
MR_T2/ MR_Gad/PET	LLE	0.4247	0.3578	0.8064	0.1787	0.4459	0.0744	14.6428	2.2591	0.6562
	GPCNN	0.3621	0.2783	0.8048	0.0921	0.4428	0.0835	16.0056	2.4682	0.6268
	JLGE	0.6266	0.4100	0.8132	0.2132	0.4423	0.0755	14.4100	2.5972	0.6813
	NSFSR	0.4208	0.3749	0.8063	0.1549	0.3946	0.0898	14.9494	2.8901	0.7104
	AECSR	0.4345	0.3617	0.8066	0.1579	0.4074	0.0853	14.3990	2.7687	0.6998
	CNN	0.4446	0.3510	0.8069	0.1772	0.4565	0.0750	14.5933	2.3305	0.6552
	IFCNN	0.4038	0.3371	0.8059	0.1612	0.4365	0.0773	15.6200	1.2455	0.6265
	U2Fusion	0.4136	0.4045	0.8053	0.1560	0.3905	0.0978	16.3610	1.1530	0.6146
	MSRPAN	0.3255	0.3254	0.8048	0.0193	0.3432	0.0678	14.9397	1.9706	0.6448
	SDNet	0.3543	0.3074	0.8047	0.0894	0.4261	0.0702	16.0174	1.4888	0.6245
	Proposed	0.7405	0.4707	0.8132	0.3260	0.3931	0.1316	14.7291	2.8528	0.7099
MR_T2/	LLE	0.4393	0.4011	0.8069	0.3328	0.3959	0.0447	12.7681	1.3042	0.5678

MR_Gad/SPECT	GPCNN	0.3108	0.2898	0.8041	0.1117	0.4037	0.0616	13.9570	-0.2181	0.5120
	JLGE	0.6827	0.4639	0.8168	0.4063	0.3904	0.0472	12.4914	1.6778	0.6134
	NSFSR	0.4574	0.4209	0.8072	0.3447	0.3548	0.0625	12.9682	1.8280	0.6344
	AECSR	0.4881	0.4102	0.8082	0.3352	0.3561	0.0534	12.5080	1.8310	0.6293
	CNN	0.5199	0.4213	0.8092	0.3411	0.4003	0.0463	12.5650	1.4958	0.5998
	IFCNN	0.4218	0.3709	0.8064	0.2966	0.3870	0.0474	13.0446	1.4359	0.6003
	U2Fusion	0.4222	0.4339	0.8053	0.2400	0.3280	0.0639	14.2351	1.5536	0.6186
	MSRPAN	0.3176	0.3721	0.8045	0.0430	0.3012	0.0398	12.5389	1.7474	0.5862
	SDNet	0.3349	0.3392	0.8043	0.1273	0.3940	0.0444	13.5890	1.4259	0.5990
	Proposed	0.7981	0.4945	0.8155	0.5135	0.3285	0.0953	12.7601	1.8971	0.6311

Table 4. Objective evaluation of fused images Gaussian noise 40.

	Methods	Q_{MI}	Q_{TE}	Q_{NCIE}	Q_P	Q_{CB}	Q_{SSIM}	**PSNR**	**CNR**	**CC**
CT/MR_T2 /SPECT	LLE	0.4762	0.3904	0.8080	0.2600	0.4773	0.0910	12.6966	0.9404	0.6724
	GPCNN	0.3556	0.3124	0.8052	0.0821	0.4355	0.0734	14.6499	1.8656	0.6868
	JLGE	0.7091	0.4554	0.8176	0.3210	0.4640	0.0949	12.6754	1.4935	0.7051
	NSFSR	0.4732	0.4032	0.8079	0.1973	0.4029	0.1085	13.1484	1.6369	0.7277
	AECSR	0.4699	0.3960	0.8078	0.2245	0.4246	0.1053	12.4652	1.6232	0.7094
	CNN	0.5417	0.4073	0.8097	0.2333	0.4686	0.0958	12.7772	1.2101	0.6932
	IFCNN	0.4379	0.3641	0.8072	0.2181	0.4471	0.1040	13.4640	1.2423	0.6856
	U2Fusion	0.4359	0.4171	0.8061	0.1598	0.3845	0.1179	15.2366	1.8880	0.7434
	MSRPAN	0.3861	0.3625	0.8061	0.0413	0.3520	0.0851	12.3943	1.9761	0.6706
	SDNet	0.3736	0.3364	0.8054	0.1023	0.4333	0.0887	14.0147	1.6281	0.6982
	Proposed	0.8122	0.4789	0.8160	0.4731	0.3940	0.1566	12.8667	1.7362	0.7201
MR_T1/ MR_T2/PET	LLE	0.4293	0.4013	0.8067	0.2874	0.4118	0.0458	11.1810	1.5598	0.5767
	GPCNN	0.3732	0.3239	0.8049	0.1225	0.4319	0.0418	11.9532	0.8593	0.5509
	JLGE	0.6519	0.4644	0.8155	0.3531	0.3970	0.0468	11.0065	1.9087	0.6149
	NSFSR	0.4485	0.4251	0.8072	0.2956	0.3696	0.0542	11.3907	2.1790	0.6400
	AECSR	0.4904	0.4192	0.8086	0.2996	0.3804	0.0517	10.9869	2.0953	0.6346
	CNN	0.4420	0.3931	0.8071	0.2872	0.4153	0.0470	11.1573	1.6254	0.5691
	IFCNN	0.4166	0.3816	0.8063	0.2525	0.4125	0.0466	11.7341	1.1223	0.5626
	U2Fusion	0.4306	0.4324	0.8056	0.2168	0.3693	0.0585	12.4644	0.9751	0.5476
	MSRPAN	0.3112	0.3703	0.8046	0.0164	0.3176	0.0317	11.0286	1.7189	0.5587
	SDNet	0.3483	0.3449	0.8046	0.1171	0.4065	0.0427	11.7505	0.6466	0.5239
	Proposed	0.7451	0.4958	0.8152	0.4045	0.3519	0.0740	11.2837	2.2006	0.6438
MR_T1/ MR_T2/SPECT	LLE	0.4433	0.3826	0.8078	0.3177	0.4863	0.0393	11.2312	1.5953	0.5547
	GPCNN	0.3287	0.3057	0.8047	0.0970	0.4581	0.0475	13.0368	1.5204	0.5644
	JLGE	0.7254	0.4499	0.8211	0.4172	0.4892	0.0395	10.8859	2.2774	0.6109
	NSFSR	0.4485	0.4003	0.8077	0.2620	0.4067	0.0504	11.4293	2.6638	0.6434
	AECSR	0.4801	0.3963	0.8088	0.2947	0.4339	0.0461	10.9032	2.4340	0.6356
	CNN	0.5330	0.4073	0.8107	0.3116	0.4750	0.0419	11.1161	2.3580	0.6031
	IFCNN	0.4136	0.3561	0.8069	0.2627	0.4594	0.0414	11.7152	1.9803	0.5985
	U2Fusion	0.4052	0.4099	0.8057	0.1922	0.4128	0.0600	13.3190	2.0366	0.6303
	MSRPAN	0.3265	0.3529	0.8051	0.0396	0.3582	0.0339	11.1812	2.3026	0.6038
	SDNet	0.3497	0.3236	0.8050	0.1100	0.4431	0.0374	12.1615	1.7950	0.6007
	Proposed	0.8451	0.4993	0.8213	0.6061	0.4363	0.0765	11.2144	2.6090	0.6379
MR_T2/ MR_Gad/PET	LLE	0.3919	0.3419	0.8058	0.1468	0.4357	0.0607	14.1971	2.0098	0.6291
	GPCNN	0.3161	0.2581	0.8042	0.0719	0.4376	0.0619	15.6805	2.2139	0.5986
	JLGE	0.5841	0.3937	0.8121	0.1818	0.4351	0.0615	14.0367	2.3610	0.6588
	NSFSR	0.3857	0.3613	0.8057	0.1261	0.3861	0.0733	14.6677	2.7620	0.6969
	AECSR	0.3934	0.3464	0.8059	0.1304	0.4000	0.0691	14.1043	2.5777	0.6828
	CNN	0.4148	0.3420	0.8064	0.1444	0.4462	0.0604	14.1008	2.0186	0.6287
	IFCNN	0.3646	0.3225	0.8053	0.1343	0.4263	0.0625	15.1433	0.9340	0.5929
	U2Fusion	0.3788	0.3893	0.8049	0.1356	0.3985	0.0842	16.1585	1.0307	0.5958
	MSRPAN	0.2945	0.3118	0.8044	0.0179	0.3395	0.0549	14.4213	1.7299	0.6219
	SDNet	0.3054	0.2806	0.8041	0.0727	0.4110	0.0548	15.4014	1.0658	0.5824
	Proposed	0.7227	0.4695	0.8131	0.3072	0.3983	0.1097	14.6986	2.8256	0.7071
MR_T2/ MR_Gad/SPECT	LLE	0.4101	0.3966	0.8065	0.2899	0.3914	0.0354	12.5435	1.0830	0.5491
	GPCNN	0.2795	0.2838	0.8038	0.0970	0.3957	0.0412	13.8009	-0.5074	0.4877
	JLGE	0.6579	0.4619	0.8166	0.3573	0.3883	0.0365	12.3162	1.4948	0.5997
	NSFSR	0.4192	0.4137	0.8066	0.2919	0.3485	0.0477	12.9624	1.7717	0.6312
	AECSR	0.4473	0.4041	0.8075	0.2856	0.3505	0.0409	12.3943	1.7128	0.6202
	CNN	0.4908	0.4199	0.8088	0.2968	0.3934	0.0359	12.3596	1.2991	0.5825
	IFCNN	0.3867	0.3685	0.8059	0.2584	0.3824	0.0369	12.8577	1.2599	0.5839
	U2Fusion	0.3877	0.4246	0.8049	0.2107	0.3402	0.0534	14.1421	1.4656	0.6091
	MSRPAN	0.2972	0.3673	0.8043	0.0398	0.2968	0.0313	12.3157	1.5849	0.5757
	SDNet	0.2976	0.3238	0.8039	0.1073	0.3838	0.0341	13.2726	1.1840	0.5765
	Proposed	0.7593	0.4997	0.8147	0.4859	0.3246	0.0726	12.8040	1.8925	0.6301

Table 5. Objective evaluation of fused images Poisson noise. (red: the best; blue: suboptimal)

Images	**Methods**	Q_{MI}	Q_{TE}	Q_{NCIE}	Q_P	Q_{CB}	Q_{SSIM}	**PSNR**	**CNR**	**CC**
CT/MR_T2 /SPECT	LLE	0.7576	0.3805	0.8109	0.3924	0.6970	0.5036	13.2523	1.4796	0.7188
	GPCNN	0.6443	0.3521	0.8082	0.1703	0.5858	0.4991	15.1149	1.9729	0.7277
	JLGE	0.9811	0.4001	0.8144	0.5629	0.7385	0.5854	12.9266	1.8587	0.7352
	NSFSR	0.8657	0.3830	0.8116	0.4723	0.7213	0.5967	13.0595	1.7720	0.7384
	AECSR	0.9250	0.3988	0.8125	0.5039	0.7195	0.5908	12.5106	1.8243	0.7309
	CNN	0.7469	0.4326	0.8106	0.4308	0.5507	0.4988	13.2550	1.4557	0.7287
	IFCNN	0.7329	0.3415	0.8085	0.4105	0.7268	0.6036	13.9720	1.7140	0.7318
	U2Fusion	0.6944	0.5414	0.8081	0.2897	0.3596	0.1907	15.7547	2.2071	0.7768
	MSRPAN	0.6828	0.3229	0.8079	0.0532	0.6195	0.5771	12.9417	2.5634	0.7074

	SDNet	0.7345	0.4267	0.8086	0.2805	0.6907	0.3175	15.1741	2.3792	0.7666
	Proposed	1.0021	0.4076	0.8157	0.5352	0.7288	0.5851	12.7097	1.9029	0.7331
MR_T1/ MR_T2/PET	LLE	0.7099	0.3589	0.8097	0.4110	0.6418	0.4289	11.4087	2.0726	0.6148
	GPCNN	0.6443	0.3484	0.8073	0.2367	0.5501	0.3992	11.8420	1.0679	0.5784
	JLGE	0.9190	0.3839	0.8148	0.4858	0.6701	0.4392	11.1175	2.2632	0.6406
	NSFSR	0.8770	0.3806	0.8136	0.4536	0.6606	0.4411	11.2007	2.2899	0.6462
	AECSR	0.9096	0.3869	0.8141	0.4118	0.6566	0.4410	10.9938	2.3572	0.6512
	CNN	0.6137	0.3821	0.8079	0.4040	0.5313	0.3709	11.3858	1.8874	0.6008
	IFCNN	0.6769	0.3377	0.8073	0.3629	0.6612	0.4435	11.9944	1.7560	0.6084
	U2Fusion	0.7194	0.5551	0.8078	0.3174	0.3359	0.0877	12.5848	1.1331	0.5631
	MSRPAN	0.5231	0.2913	0.8056	0.0175	0.5564	0.4226	11.2727	2.1760	0.5890
	SDNet	0.6744	0.4031	0.8067	0.2200	0.6077	0.2057	12.1171	1.2456	0.5698
	Proposed	0.9575	0.3929	0.8168	0.4763	0.6672	0.4405	11.0680	2.3315	0.6480
MR_T1/ MR_T2/SPECT	LLE	0.6910	0.3811	0.8109	0.5116	0.6466	0.3460	11.4741	2.1199	0.5942
	GPCNN	0.5949	0.3568	0.8079	0.2442	0.5457	0.3362	13.1083	2.2175	0.5942
	JLGE	1.0193	0.4317	0.8224	0.7054	0.6667	0.3424	10.9908	2.6172	0.6385
	NSFSR	0.9371	0.4217	0.8189	0.6607	0.6256	0.0504	11.4293	2.6638	0.6434
	AECSR	1.0112	0.4327	0.8217	0.6809	0.6181	0.3460	10.8624	2.6627	0.6495
	CNN	0.6691	0.4085	0.8115	0.5253	0.5511	0.2626	11.4010	2.4276	0.6243
	IFCNN	0.6498	0.3496	0.8085	0.4606	0.6064	0.3767	11.8927	2.4525	0.6366
	U2Fusion	0.6257	0.5019	0.8078	0.3171	0.3915	0.0926	13.4992	2.2280	0.6518
	MSRPAN	0.5131	0.3133	0.8062	0.0577	0.5042	0.3677	11.3845	2.6477	0.6280
	SDNet	0.6290	0.4026	0.8077	0.2564	0.6053	0.1832	12.6144	2.3347	0.6502
	Proposed	1.0825	0.4414	0.8265	0.7026	0.6501	0.3528	10.9723	2.6829	0.6436
MR_T2/ MR_Gad/PET	LLE	0.6393	0.3487	0.8078	0.3250	0.6348	0.4578	15.2850	2.8002	0.7013
	GPCNN	0.6190	0.3315	0.8073	0.2361	0.5812	0.4506	16.3904	3.0400	0.6758
	JLGE	0.8848	0.3876	0.8130	0.4285	0.6728	0.4593	14.8840	2.9670	0.7160
	NSFSR	0.7821	0.3775	0.8104	0.4030	0.6595	0.4657	14.9909	3.0503	0.7229
	AECSR	0.8564	0.3883	0.8120	0.4025	0.6459	0.4643	14.7321	3.0393	0.7240
	CNN	0.5846	0.3572	0.8077	0.3390	0.5401	0.4133	15.2958	2.7553	0.6919
	IFCNN	0.6470	0.3380	0.8073	0.3166	0.6630	0.5004	16.2517	1.9675	0.6843
	U2Fusion	0.6402	0.5159	0.8072	0.2725	0.3695	0.1363	16.7083	1.5351	0.6463
	MSRPAN	0.5420	0.2842	0.8061	0.0300	0.5561	0.4732	15.5710	2.4408	0.6815
	SDNet	0.6715	0.4171	0.8074	0.2706	0.6270	0.2570	16.8248	2.1287	0.6814
	Proposed	0.9167	0.3923	0.8141	0.4265	0.6570	0.4621	14.7312	2.9807	0.7216
MR_T2/ MR_Gad/SPECT	LLE	0.7362	0.3563	0.8084	0.4811	0.6141	0.4879	13.0227	1.7003	0.6015
	GPCNN	0.5809	0.3091	0.8059	0.1698	0.5328	0.4662	13.9199	0.3880	0.5358
	JLGE	0.9968	0.3930	0.8142	0.6580	0.6319	0.4915	12.6461	1.9463	0.6363
	NSFSR	0.8953	0.3835	0.8117	0.6132	0.5876	0.4974	12.6870	1.8959	0.6348
	AECSR	0.9541	0.3895	0.8128	0.5966	0.5915	0.4946	12.5539	2.0445	0.6433
	CNN	0.7325	0.3873	0.8088	0.4972	0.5287	0.4343	12.8322	1.7425	0.6243
	IFCNN	0.6931	0.3333	0.8067	0.4516	0.5903	0.5054	13.2074	1.7947	0.6297
	U2Fusion	0.7032	0.5313	0.8070	0.3448	0.2988	0.0928	14.3608	1.6608	0.6300
	MSRPAN	0.5662	0.3057	0.8054	0.0553	0.5131	0.4801	12.7206	2.0647	0.6073
	SDNet	0.6789	0.4257	0.8061	0.2668	0.6107	0.2186	13.9170	1.7032	0.6253
	Proposed	1.0498	0.3976	0.8164	0.6399	0.6210	0.4933	12.6624	2.0436	0.6406