



Balancing Task-invariant Interaction and Task-specific Adaptation for Unified Image Fusion

Xingyu Hu¹, Junjun Jiang^{1*}, Chenyang Wang¹, Kui Jiang¹, Xianming Liu¹, Jiayi Ma²

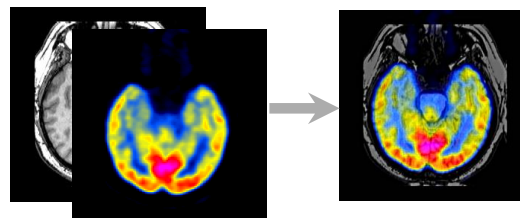
¹Harbin Institute of Technology ²Wuhan University *Corresponding author

Definition

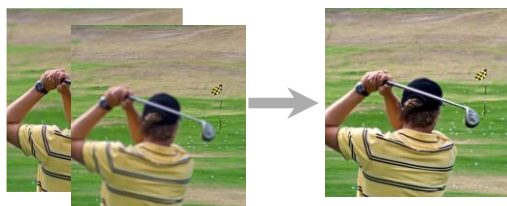
- **Unified Image Fusion** aims to integrate complementary information from multi-source images.



Infrared-visible image fusion



Medical Image Fusion



Multi-focus image fusion



Multi-exposure Image Fusion

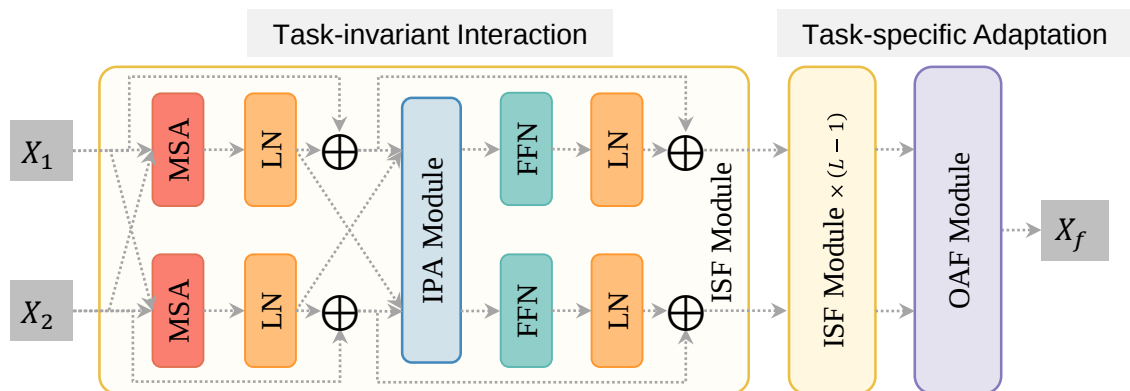
Challenges

- **Limited performance.** Existing unified image fusion methods often neglect task-specific characteristics.
- **Restricted generalization.** Existing general image fusion methods rely on task identification during inference.

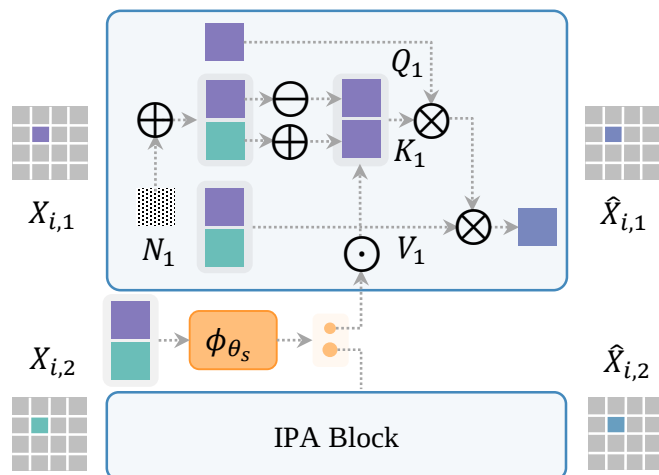
Contributions

- Establishing a unified image fusion framework that simultaneously explores the task-invariant interactions and task-specific adaptations.
- An IPA block is introduced to explore task-invariant properties. An OAF module is designed to capture task-specific properties without explicit task identification. The framework is reinforced by FAMO strategy to mitigate objective conflicts.
- Extensive experiments demonstrate the effectiveness.

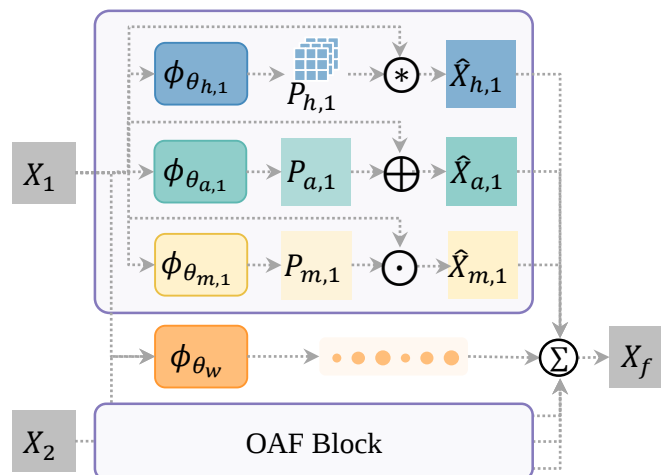
TITA framework



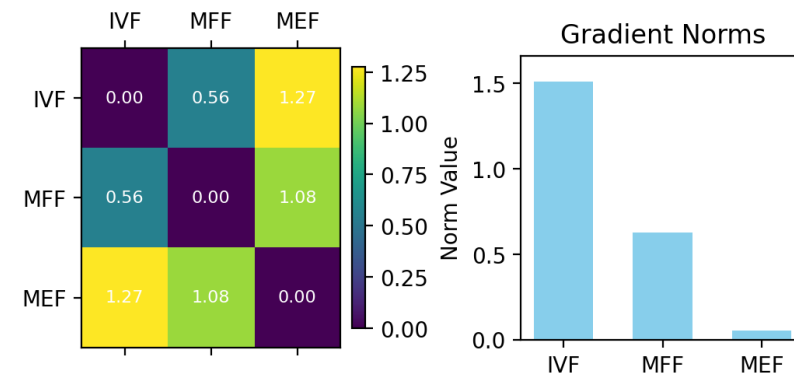
IPA Module



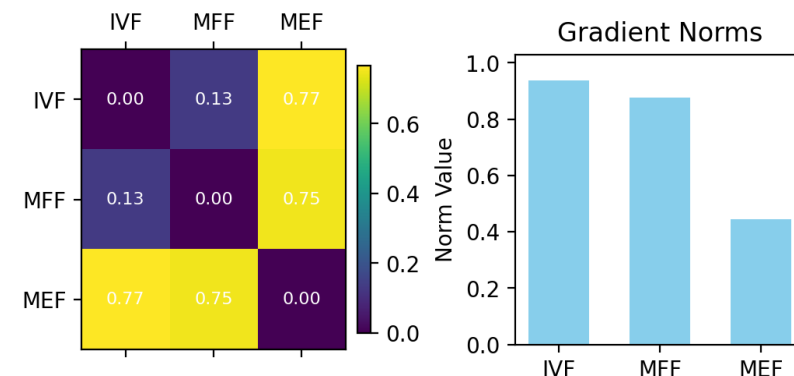
OAF Module



FAMO



(a) W/o FAMO



(b) W/ FAMO

➤ Gradient conflicts can be observed during multi-fusion task learning.

Quantitative Results on IVF task

Table 1. The quantitative results for IVF task. (**Bold**: best; Underline: second best.)

Method	MI	FMI	Qabf	Qp	Qw	VIF
Specialized						
DenseFuse [17]	2.687	0.877	0.317	0.309	0.559	0.675
TarDAL [22]	3.152	0.862	0.413	0.285	0.614	0.710
DDFM [59]	2.921	0.884	0.507	0.427	0.686	0.749
Text-IF [48]	3.322	<u>0.892</u>	0.684	<u>0.465</u>	<u>0.859</u>	0.932
General						
SwinFusion [30]	3.873	0.889	0.650	0.457	0.844	0.907
TC-MoA [62]	<u>3.606</u>	0.886	0.600	0.392	0.855	0.925
Unified						
IFCNN [57]	2.821	0.878	0.582	0.361	0.840	0.773
PMGI [51]	3.096	0.869	0.176	0.223	0.333	0.544
U2Fusion [42]	2.447	0.870	0.378	0.303	0.625	0.576
FusionDN [43]	2.666	0.871	0.494	0.328	0.753	0.758
DeFusion [19]	2.687	0.877	0.317	0.316	0.676	0.675
CCF [4]	2.789	0.881	0.499	0.347	0.726	0.719
TITA (Ours)	4.176	0.896	<u>0.679</u>	0.473	0.877	<u>0.926</u>

Quantitative Results on MEF task

Table 2. The quantitative results for MEF task. (**Bold**: best; Underline: second best.)

Method	MI	FMI	SD	EI	Qw	VIF
Specialized						
MEF-GAN [44]	4.844	0.874	10.26	45.96	0.589	1.371
HoLoCo [25]	4.644	0.874	10.37	49.85	0.690	1.463
General						
SwinFusion [30]	5.287	0.901	10.26	<u>54.45</u>	0.918	1.463
TC-MoA [62]	5.505	0.890	10.23	49.12	0.841	1.485
Unified						
IFCNN [57]	5.695	0.888	10.37	53.94	0.848	1.436
PMGI [51]	5.093	0.878	10.28	35.12	0.597	1.086
U2Fusion [42]	5.526	0.882	10.14	43.19	0.778	1.301
FusionDN [43]	5.762	0.880	10.46	49.90	0.763	1.403
DeFusion [19]	4.626	0.882	<u>10.46</u>	42.05	0.758	1.159
CCF [4]	<u>5.879</u>	0.885	10.44	39.48	0.703	<u>1.515</u>
TITA (Ours)	6.207	<u>0.900</u>	10.73	55.07	<u>0.891</u>	1.534

Quantitative Results on MFF task

Table 3. The quantitative results for MFF task. (**Bold**: best; Underline: second best.)

Method	MI	FMI	Qabf	SSIM	Qw	VIF
Specialized						
IFCNN [57]	6.495	<u>0.882</u>	0.658	0.991	0.912	1.614
MFF-GAN [52]	5.749	<u>0.875</u>	0.628	0.980	0.892	1.468
General						
SwinFusion [30]	6.261	0.881	<u>0.687</u>	<u>0.991</u>	0.893	1.633
TC-MoA [62]	6.695	0.881	<u>0.600</u>	<u>0.990</u>	0.891	1.655
Unified						
PMGI [51]	5.511	0.866	0.351	0.902	0.523	1.340
U2Fusion [42]	5.219	0.869	0.469	0.902	0.518	1.392
FusionDN [43]	5.451	0.863	0.434	0.880	0.485	1.407
DeFusion [19]	5.833	0.870	0.472	0.960	0.693	1.569
CCF [4]	5.823	0.875	0.474	0.952	0.651	1.604
TITA (Ours)	<u>6.546</u>	0.885	0.697	0.993	<u>0.907</u>	<u>1.637</u>

Ablation Results

Table 4. The ablation study on three main components.

TI	TA	MO	MI	FMI	Qabf	VIF	Params
	Baseline		2.9632	0.8841	0.4581	0.7027	0.97M
	Baseline-TS		3.6116	0.8887	0.6464	0.8448	0.97M
✓			3.6853	0.8893	0.6509	0.8546	1.30M
	✓		3.8822	0.8922	0.6639	0.9038	1.06M
		✓	3.6802	0.8909	0.6619	0.8531	0.97M
✓	✓		3.8832	0.8928	0.6663	0.9061	1.39M
✓		✓	3.7546	0.8920	0.6671	0.8650	1.30M
	✓	✓	4.1220	0.8948	0.6763	0.9191	1.06M
	Ours		4.1759	0.8959	0.6795	0.9264	1.39M

Qualitative Results on IVF task

(a) I_1 (b) I_2

(c) DenseFuse

(d) TarDAL

(e) DDFM

(f) Text-IF

(g) SwinFusion



(h) TC-MoA

(i) IFCNN

(j) U2Fusion

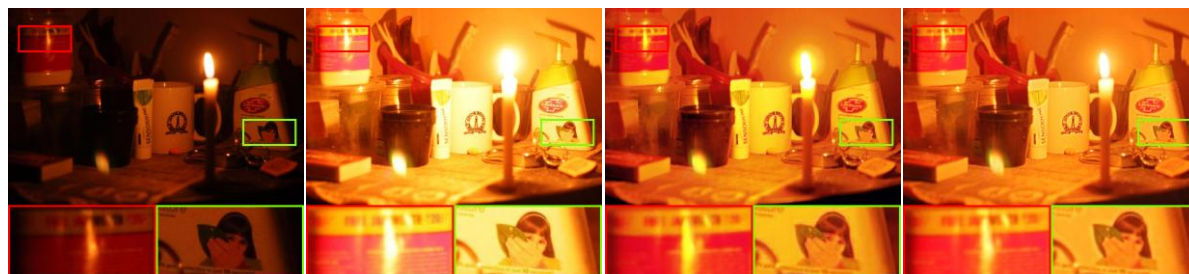
(k) FusionDN

(l) DeFusion

(m) CCF

(n) TITA

Qualitative Results on MEF task



(a) I_1

(b) I_2

(c) MEF-GAN

(d) HoLoCo



(e) SwinFusion

(f) TC-MoA

(g) IFCNN

(h) U2Fusion



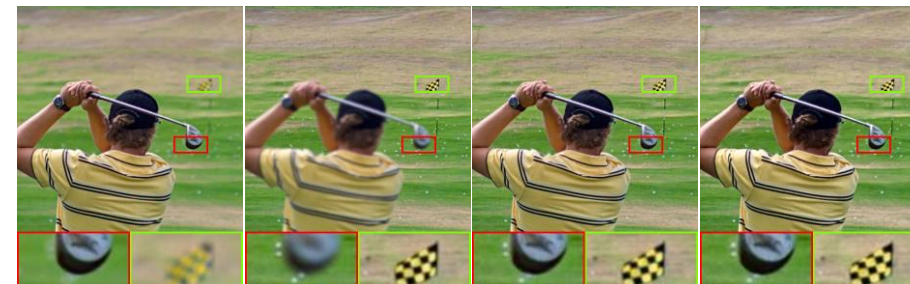
(i) FusionDN

(j) DeFusion

(k) CCF

(l) TITA

Qualitative Results on MEF task

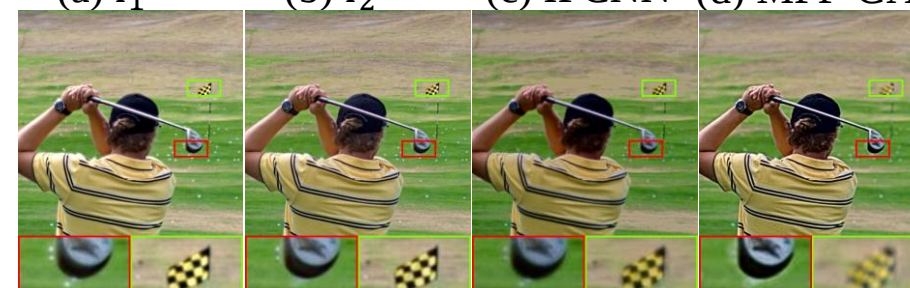


(a) I_1

(b) I_2

(c) IFCNN

(d) MFF-GAN

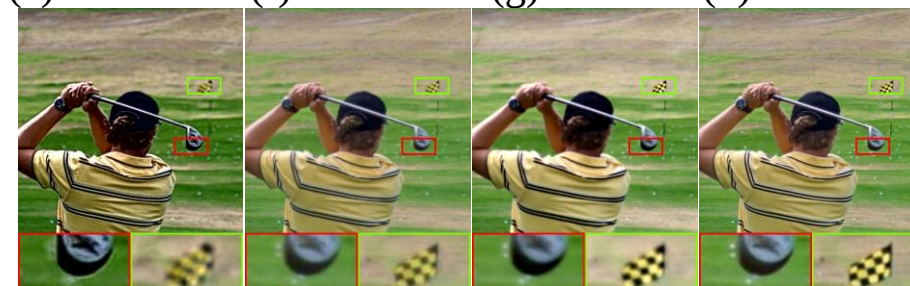


(e) SwinFusion

(f) TC-MoA

(g) PMGI

(h) U2Fusion



(i) FusionDN

(j) DeFusion

(k) CCF

(l) TITA