SmartAssign: Learning a smart knowledge assignment strategy for deraining and desnowing

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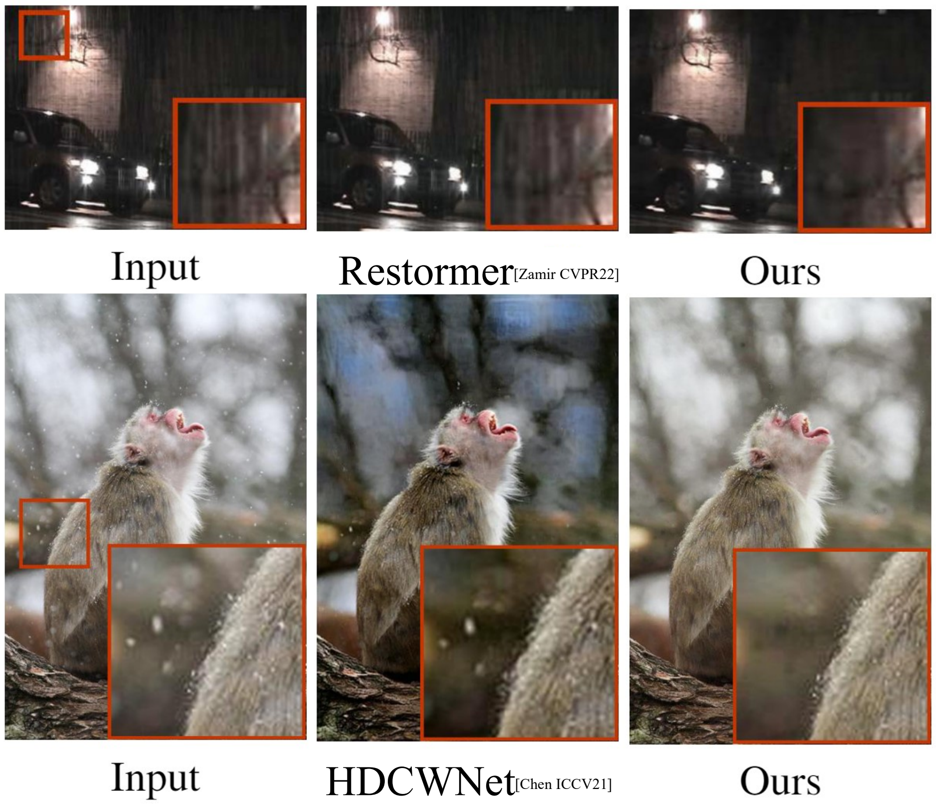
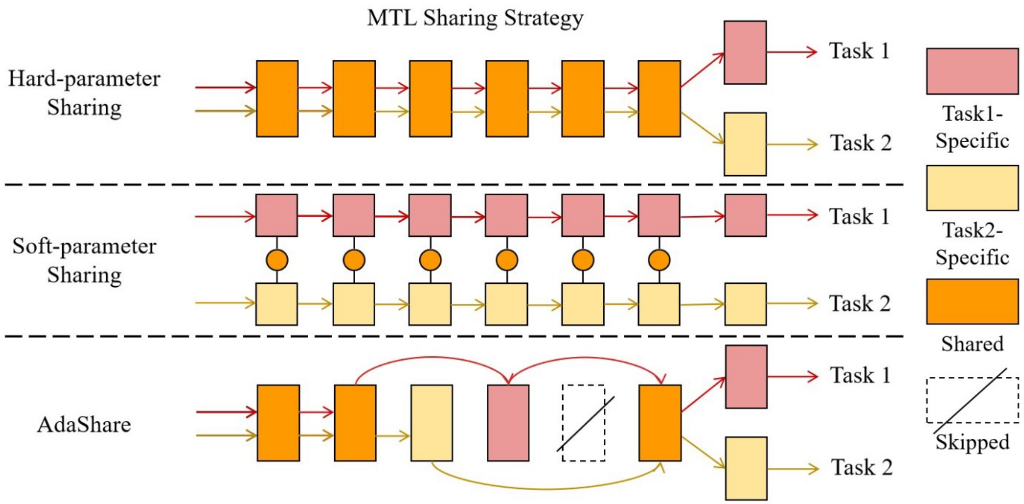
TUE-AM-350



Existing Assignment Strategies

- Hard sharing
  - neglect the uniqueness of different tasks
- Soft sharing
  - each task has a network branch, leading to large model
- Adshare
  - still do not separate the uniqueness and connections of different tasks

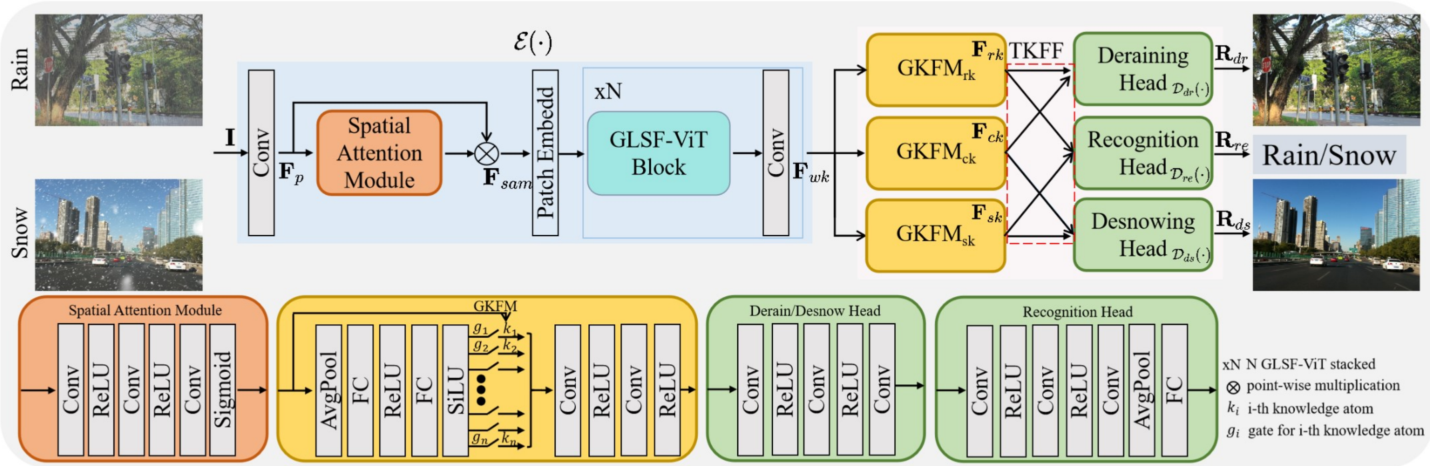


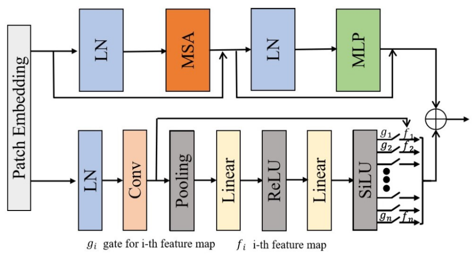
Contributions

- **Solves issues**
  - Accurate knowledge assignment in multi-task learning
  - Build a new transformer block to model the long- and short-range context depedencies
- **Contributions**
  - Propose a novel knowledge assignment strategy to excavate the connections and uniqueness of rain and snow, so that the connections are used to enhance both tasks and the uniqueness is applied to boost corresponding task and avoided from damaging other tasks
  - Propose a novel knowledge contrast mechanism to boost the accuracy of knowledge assignment
  - Propose a novel transformer block to combine the superiority of self-attention and convolution, and gate operations are introduced to alleviate the feature redudency

Network Structure

- **Our SmartAssign**





GKFM: Gated Knowledge Filtering Module

TKFF: Task-targeted Knowledge FeedForward

GLSF-ViT: Gated Long and Short range feature Fusion Vision Transformer

Loss Functions

- **Charbonnier loss**

$$\mathcal{L}_{char} = \sqrt{\|\mathbf{R} - \mathbf{G}\|^2 + \epsilon^2}$$

- **Gradient loss**

$$\mathcal{L}_{grad} = \| \bigtriangledown \mathbf{R} - \bigtriangledown \mathbf{G}\|^2$$

- **Quasi-sparsity loss**

$$\mathcal{L}_{sparsity} = \sum_{m,n} |\omega_{m,n} * \mathbf{R}| + |\omega_{m,n} * (\mathbf{I} - \mathbf{R})|$$

- **Recognition loss**

$$\mathcal{L}_{recog} = \|\mathbf{R}_{re} - \mathbf{L}\|^2$$

- **Contrastive loss**

$$\begin{aligned}\mathbf{Z} = \frac{1}{3}(&\mathbf{M}_{rk}\mathbf{M}_{rk}^{\top}/(\mathbf{M}_{rk}\mathbf{M}_{ck}^{\top} + \mathbf{M}_{rk}\mathbf{M}_{sk}^{\top}) \\ &+ \mathbf{M}_{ck}\mathbf{M}_{ck}^{\top}/(\mathbf{M}_{ck}\mathbf{M}_{rk}^{\top} + \mathbf{M}_{ck}\mathbf{M}_{sk}^{\top}) \\ &+ \mathbf{M}_{sk}\mathbf{M}_{sk}^{\top}/(\mathbf{M}_{sk}\mathbf{M}_{rk}^{\top} + \mathbf{M}_{sk}\mathbf{M}_{ck}^{\top})),\end{aligned}$$

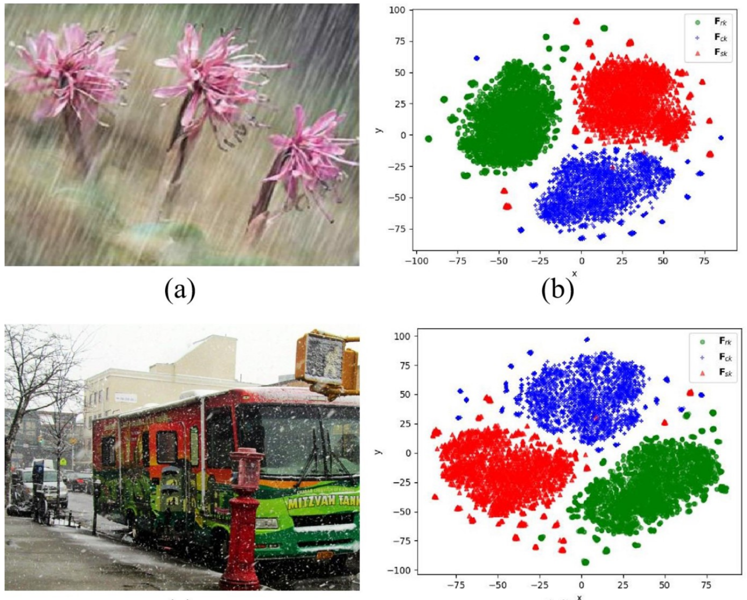
$$\mathcal{L}_{contra} = \frac{1}{C^2}\sum_{i=1}^{C}\sum_{j=1}^{C}\mathbf{Z}(i,j),$$

- **Total loss**

$$\mathcal{L} = \mathcal{L}_{char} + \mathcal{L}_{grad} + \mathcal{L}_{recog} + \lambda_1\mathcal{L}_{sparsity} + \lambda_2\mathcal{L}_{contra}$$

Experimental Results

- **Visualizing the separation of unique and shared knowledge**



(a) (b)

(c) (d)

Experimental Results

■ Quantitative evaluation

- Quantitative comparisons on deraining

Datasets	MAXIM PSNR/SSIM	DGUNet PSNR/SSIM	MPRNet PSNR/SSIM	ASV-joint PSNR/SSIM	Restormer PSNR/SSIM	TUM PSNR/SSIM	Ours PSNR/SSIM
Rain-streak	<u>33.01</u>/<u>0.924</u>	32.47/0.919	32.11/0.917	31.08/0.905	32.91/0.923	30.72/0.892	**33.16/0.931**
Rain1200	30.78/0.897	31.54/0.896	<u>32.91</u>/<u>0.916</u>	31.77/0.893	31.48/0.901	29.57/0.858	**33.07/0.927**
Real-rain	33.53/<u>0.958</u>	35.83/0.948	<u>36.04</u>/0.946	35.67/0.927	35.34/0.946	22.75/0.855	**36.55/0.962**

- Quantitative comparisons on desnowing

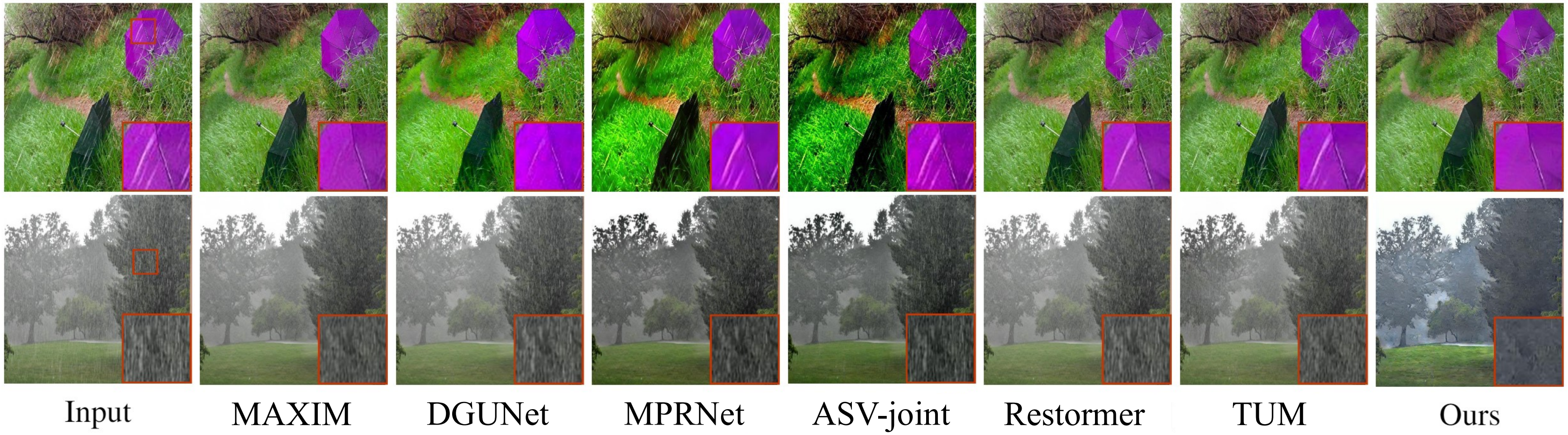
Methods	Snow100K-L PSNR/SSIM	SRRS PSNR/SSIM	CSD PSNR/SSIM
JSTASR	20.16/0.657	25.82/0.892	27.52/0.873
HDCW	20.57/0.676	27.78/0.923	29.06/0.914
TUM	<u>25.66</u>/<u>0.851</u>	<u>28.03</u>/<u>0.926</u>	<u>30.10</u>/<u>0.933</u>
Ours	**29.45/0.923**	**30.53/0.931**	**32.50/0.957**

■ Compared Methods

- MAXIM[Tu CVPR 22], DGUNet[Mou CVPR22]
- MPRNet[Zamir CVPR21], JSTASR[Chen ECCV20]
- ASV-joint[Wang ECCV 20], Restormer[Zamir CVPR22]
- TUM[Chen CVPR22], HDCW[Chen ICCV21]

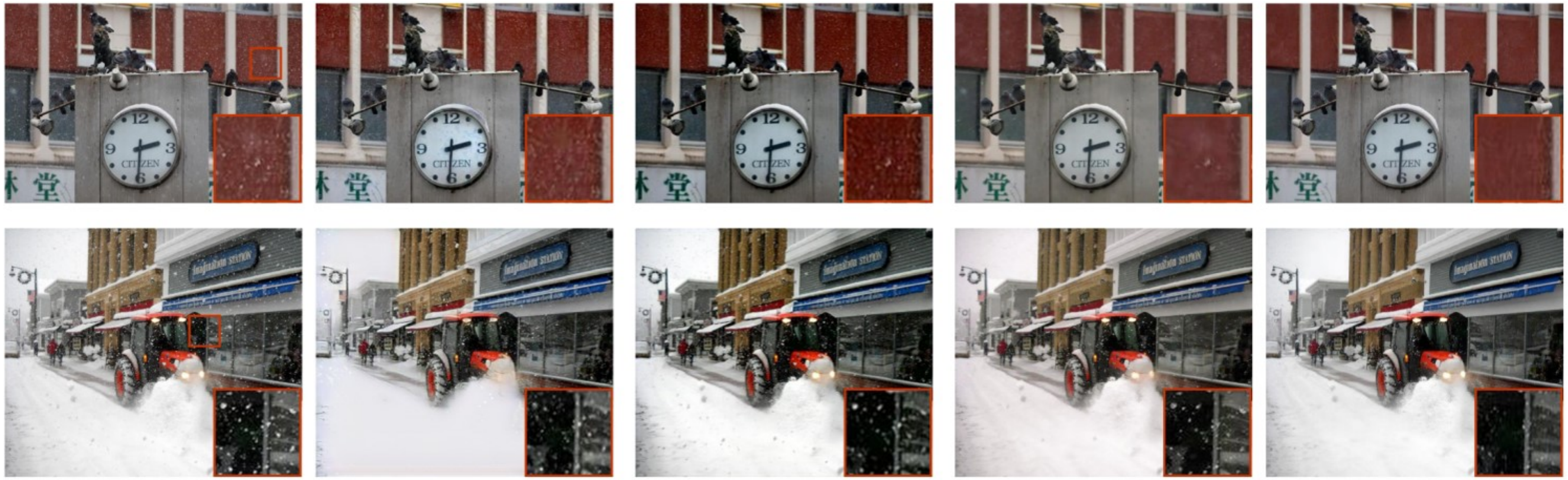
Experimental Results

- **Visual quality for deraining**



Experimental Results

- **Visual quality for desnowing**



Input JSTASR HDCW TUM Ours

Thank you!