InstructIR: High-Quality Image Restoration Following Human Instructions

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https://github.com/mv-lab/InstructIR (500 ☆)

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Outline

- Introduction

- Framework

- Method

- Experiment

- Conclusion

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Introduction

- Introduce the **first** approach that **utilizes real human-written instructions** to solve multi-task image restoration.

- Our comprehensive experiments demonstrate the potential of using text guidance for image restoration and enhancement by **achieving state-of-the-art performance** on various image restoration tasks
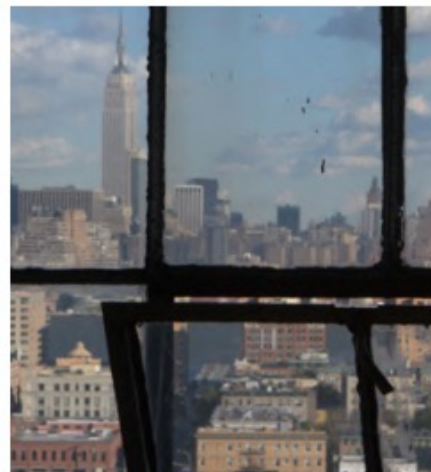
Introduction

Can you stabilize this pic? I was running...

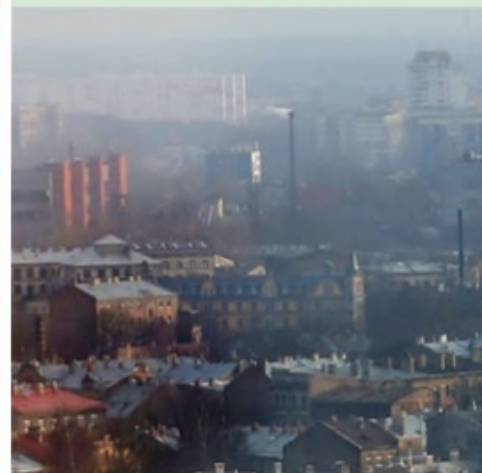My image has tiny dots, doesn't look great, fix it

My photo is too dark, I cannot see anything
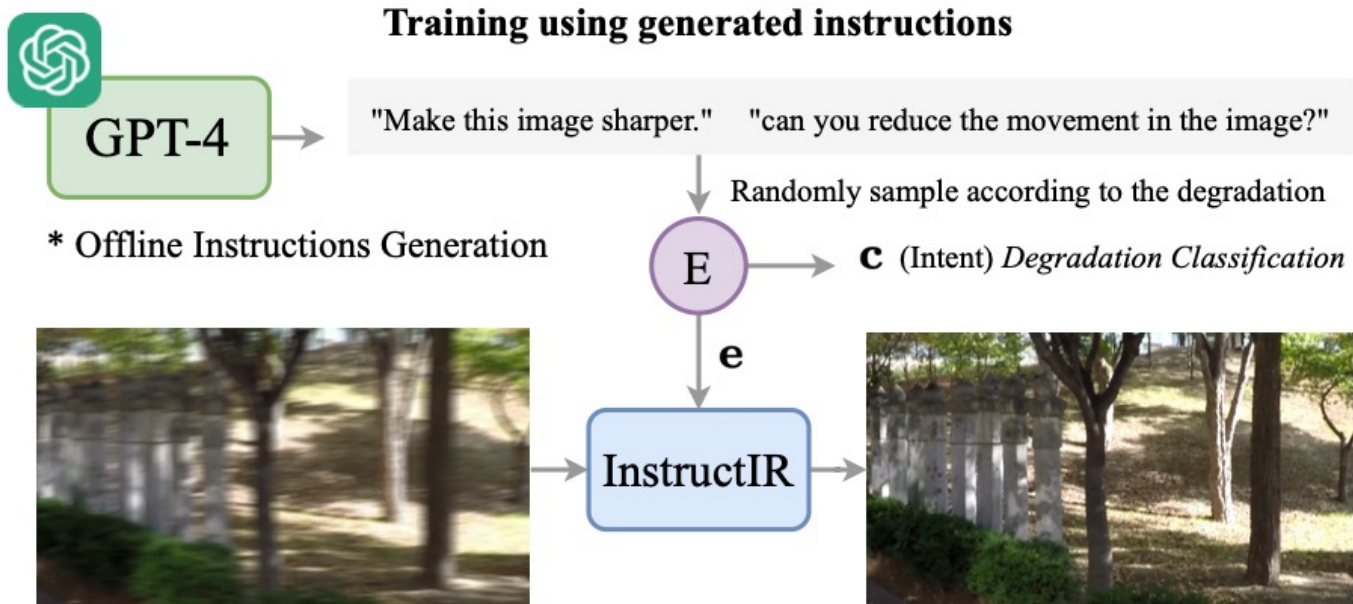
Retouch my picture like a photographer
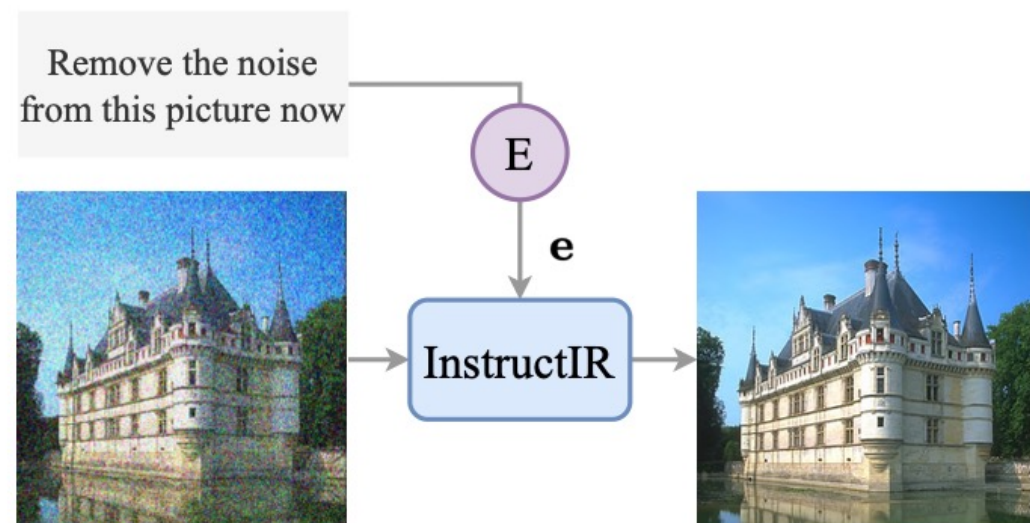
It is a foggy day, can you make it clearer?

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- **Framework**
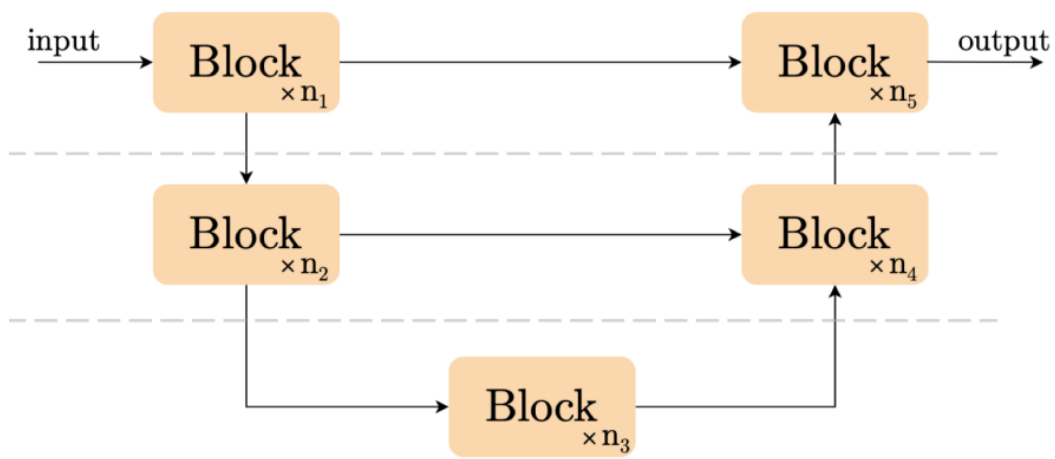
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Framework

Training using generated instructions

GPT-4

"Make this image sharper."   "can you reduce the movement in the image?"

Randomly sample according to the degradation

* Offline Instructions Generation

E → c (Intent) *Degradation Classification*

e

InstructIR

Inference using user instructions

Remove the noise from this picture now

E

e

InstructIR

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Instruction Condition Block

$$\mathcal{F}'_c = \text{Block}(\mathcal{F}_c \odot \mathbf{m}_c) + \mathcal{F}_c$$

(c) UNet Architecture(**ours**)
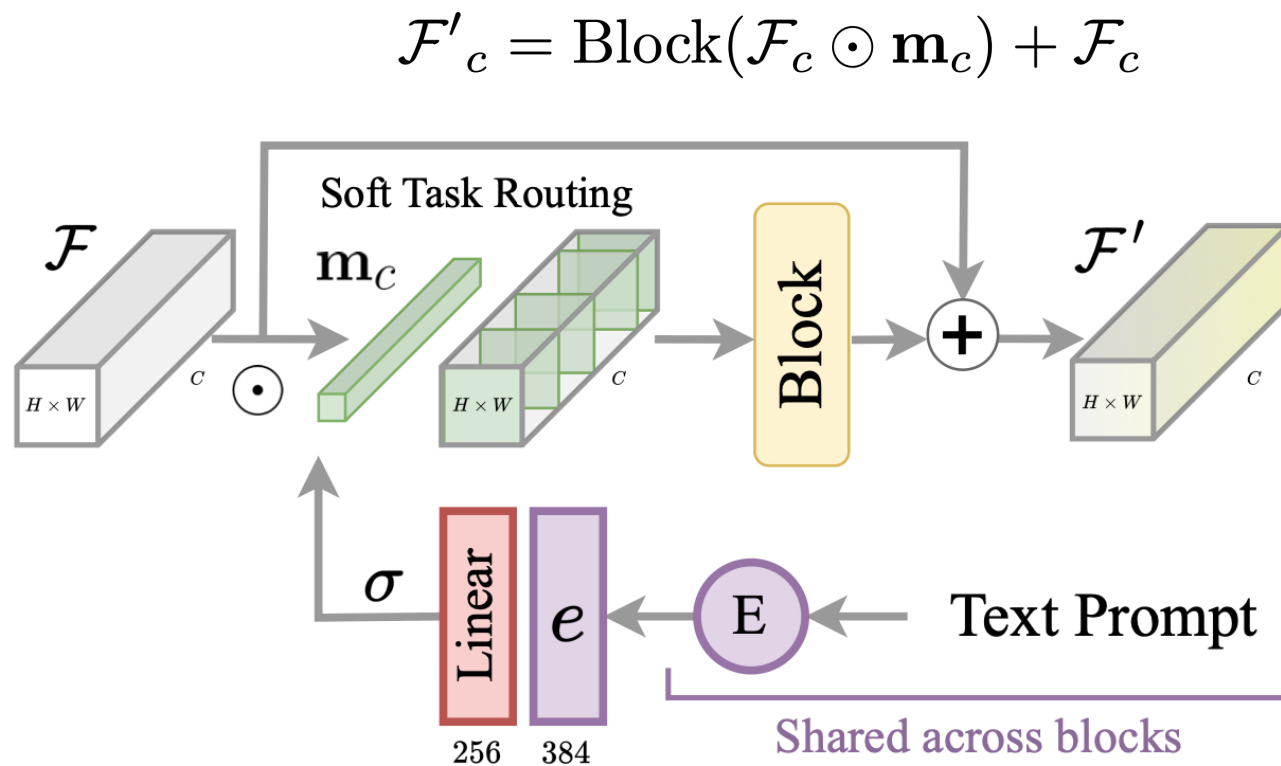
$$\mathbf{e} = \text{norm}(\mathbf{W} \cdot \text{E}(t))$$

$$F^{l+1} = \text{ICB}(\text{Block}(F^l))$$

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Degradation

	Degradation Prompts
Denoising	Can you clean the dots from my image? Fix the grainy parts of this photo Remove the noise from my picture
Deblurring	Can you reduce the movement in the image? My picture's not sharp, fix it Deblur my picture, it's too fuzzy
Dehazing	Can you make this picture clearer? Help, my picture is all cloudy Remove the fog from my photo
Deraining	I want my photo to be clear, not rainy Clear the rain from my picture Remove the raindrops from my photo
Super-Res.	Make my photo bigger and better Add details to this image Increase the resolution of this photo
Low-light	The photo is too dark, improve exposure Increase the illumination in this shot My shot has very low dynamic range
Enhancement	Make it pop! Adjust the color balance for a natural look Apply a cinematic color grade to the photo
General	Fix my image please make the image look better

Results

Methods	Deraining Rain100L [90]		Dehazing SOTS [42]		Denoising BSD68 [53]		Deblurring GoPro [58]		Low-light Enh. LOL [84]		Average		Params
	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	PSNR↑	SSIM↑	(M)
HINet [10]	35.67	0.969	24.74	0.937	31.00	0.881	26.12	0.788	19.47	0.800	27.40	0.875	88.67
DGUNet [57]	36.62	0.971	24.78	0.940	31.10	0.883	27.25	0.837	21.87	0.823	28.32	0.891	17.33
MIRNetV2 [96]	33.89	0.954	24.03	0.927	30.97	0.881	26.30	0.799	21.52	0.815	27.34	0.875	5.86
SwinIR [45]	30.78	0.923	21.50	0.891	30.59	0.868	24.52	0.773	17.81	0.723	25.04	0.835	0.91
Restormer [95]	34.81	0.962	24.09	0.927	31.49	0.884	27.22	0.829	20.41	0.806	27.60	0.881	26.13
NAFNet [9]	35.56	0.967	25.23	0.939	31.02	0.883	26.53	0.808	20.49	0.809	27.76	0.881	17.11
DL [21]	21.96	0.762	20.54	0.826	23.09	0.745	19.86	0.672	19.83	0.712	21.05	0.743	2.09
Transweather [76]	29.43	0.905	21.32	0.885	29.00	0.841	25.12	0.757	21.21	0.792	25.22	0.836	37.93
TAPE [46]	29.67	0.904	22.16	0.861	30.18	0.855	24.47	0.763	18.97	0.621	25.09	0.801	1.07
AirNet [43]	32.98	0.951	21.04	0.884	30.91	0.882	24.35	0.781	18.18	0.735	25.49	0.846	8.93
InstructIR w/o text	35.58	0.967	25.20	0.938	31.09	0.883	26.65	0.810	20.70	0.820	27.84	0.884	17.11
IDR [102]	35.63	0.965	25.24	0.943	31.60	0.887	27.87	0.846	21.34	0.826	28.34	0.893	15.34
InstructIR-**5D**	36.84	0.973	27.10	0.956	31.40	0.887	29.40	0.886	23.00	0.836	**29.55**	**0.907**	15.8
InstructIR-**6D**	36.80	0.973	27.00	0.951	31.39	0.888	29.73	0.892	22.83	0.836	**29.55**	**0.908**	15.8
InstructIR-**7D**	36.75	0.972	26.90	0.952	31.37	0.887	29.70	0.892	22.81	0.836	29.50	0.907	15.8

Results

Input

"Clean up my image, it's too fuzzy."

"Get rid of the grain in my photo"

"Remove the strange spots on my photo"

"Retouch this image and improve colors"

"Reduce the motion in this shot"

"Please get rid of the raindrops"
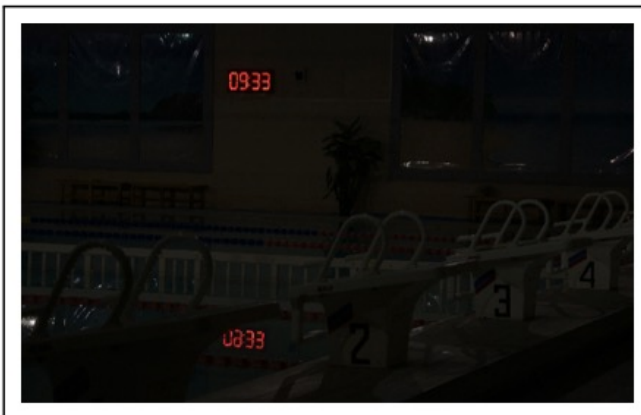
"Reduce the fog in this landmark"

Results

Input

(1) "Clear the rain from my picture" ⟶ (2) "Make it pop"

(1) "Retouch it as a photographer" ⟶ "Can you remove the raindrops?" ⟶ "Increase the resolution"

Input

(1) "My image is too dark, fix it" ⟶ (2) "Apply a tonemap"

Results

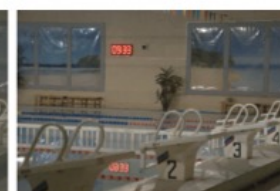Input   AirNet [43]   PromptIR [62]   *InstructIR*   Reference
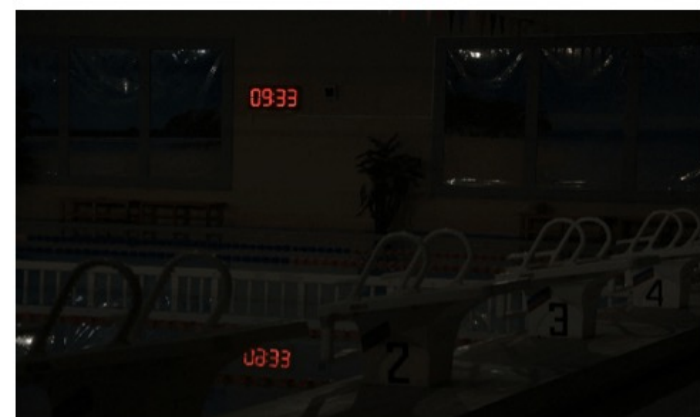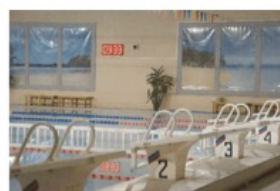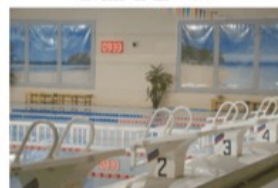

Low-light Image   NAFNet   MPRNet   DGUNet   MIRNetV2   *InstructIR*
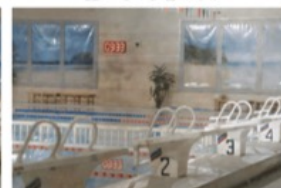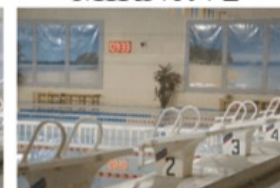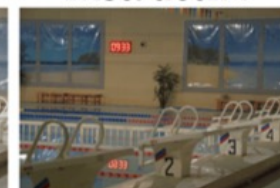TAPE   Restormer   AirNet   IDR   GT
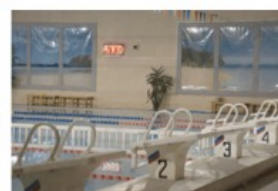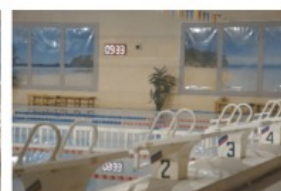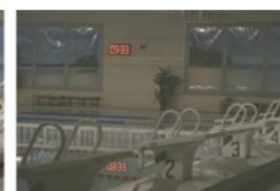
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Conclusion

- Present a novel approach that uses natural human-written instructions to guide the image restoration model

- We achieve state-of-the-art results on several restoration tasks, demonstrating the power and flexibility of instruction guidance.