Lifting the Structural Morphing for Wide-Angle Images Rectification: Unified Content and Boundary Modeling

https://lwttttt.github.io/projects/conbonet/

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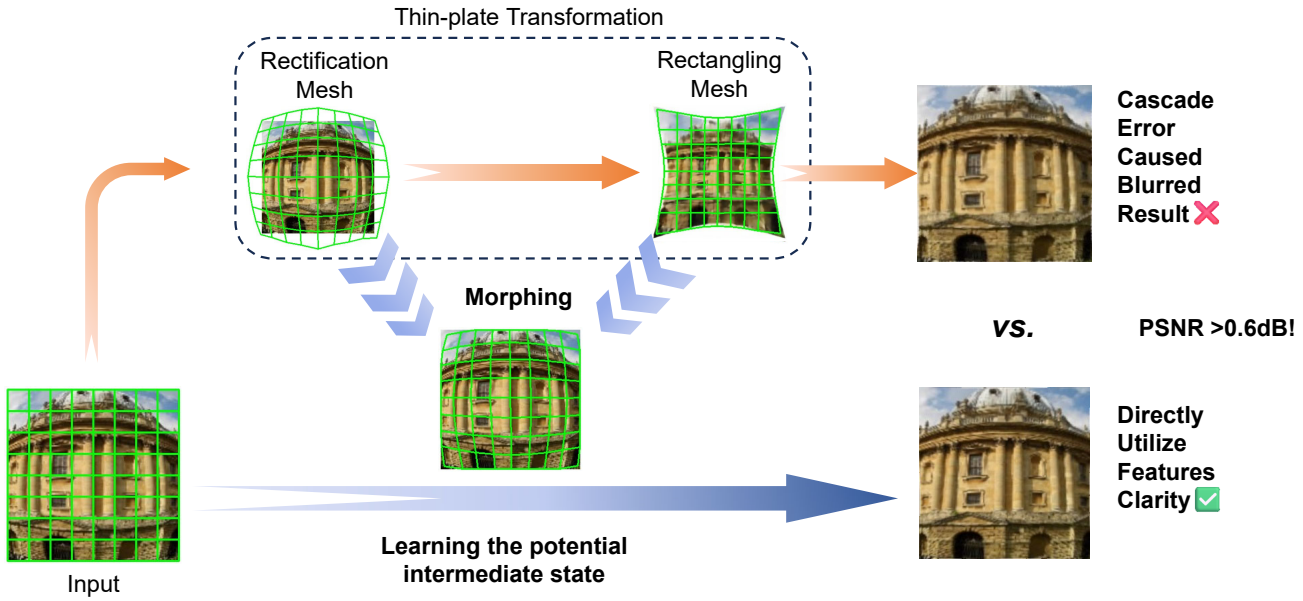
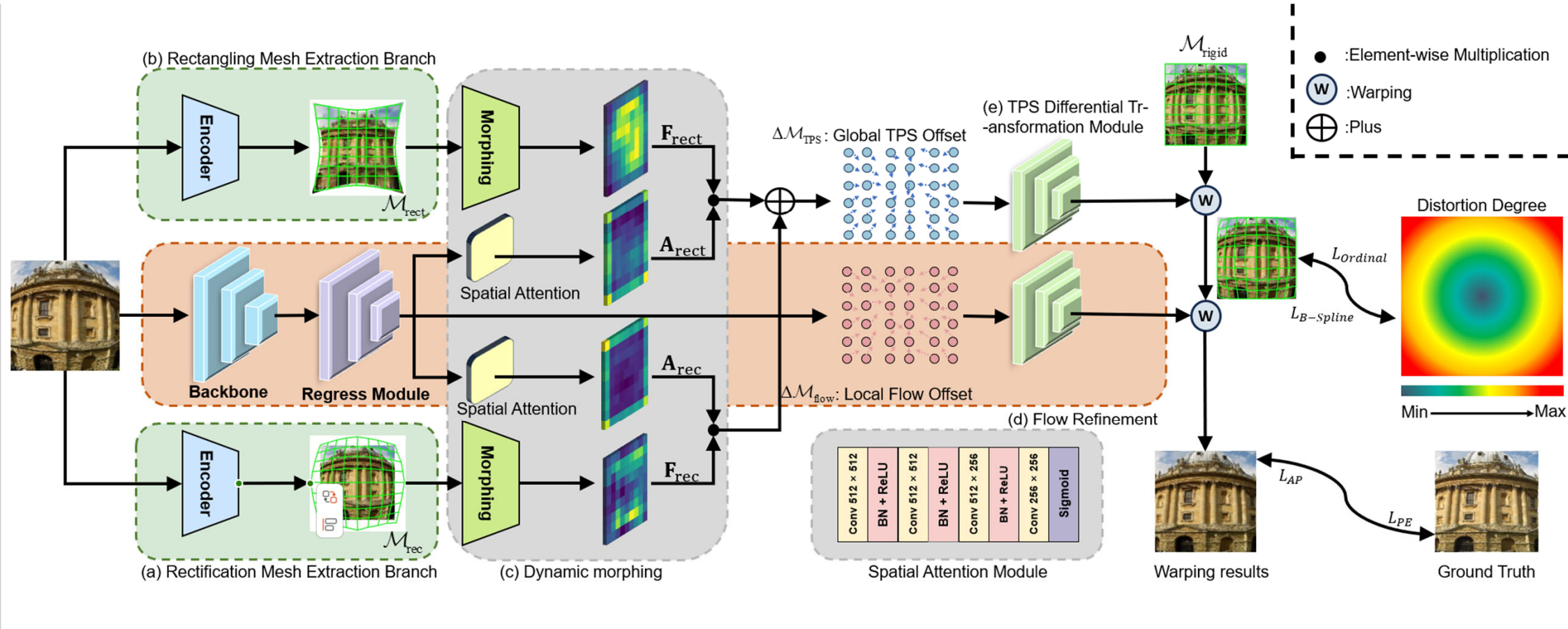
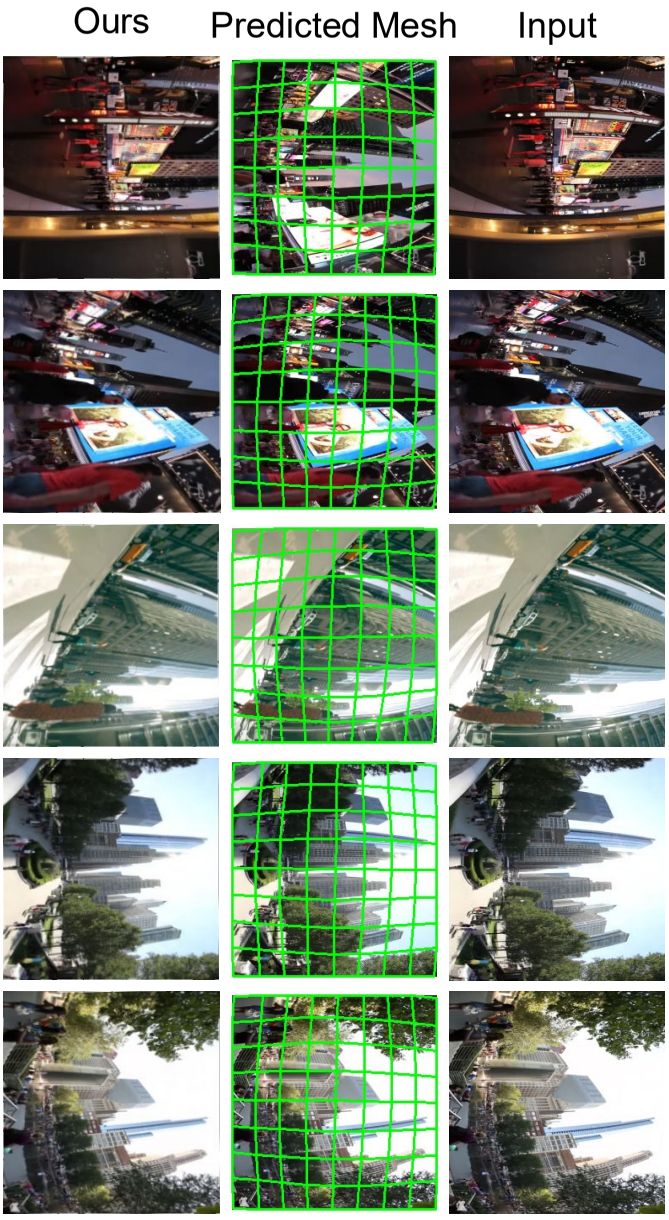


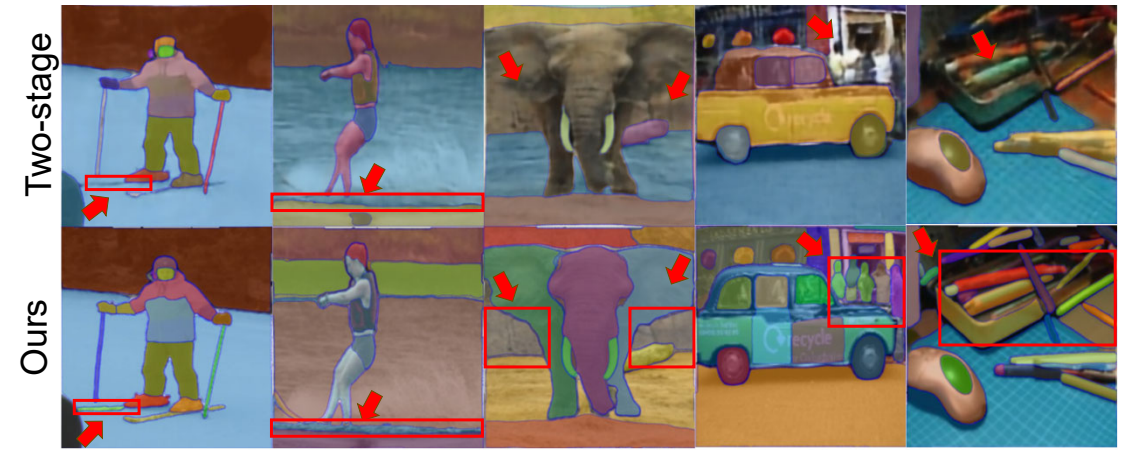
The upper branch represents the traditional cascaded correction
strategy, which includes independent rectification and rectangling
stages. The lower branch is our ConBo-Net, which uses the Thin-
Plate Spline (TPS) as a bridge to build a joint optimization strategy
for the rectification and rectangling, learning the optimal solution
for the TPS during the structural morphing.

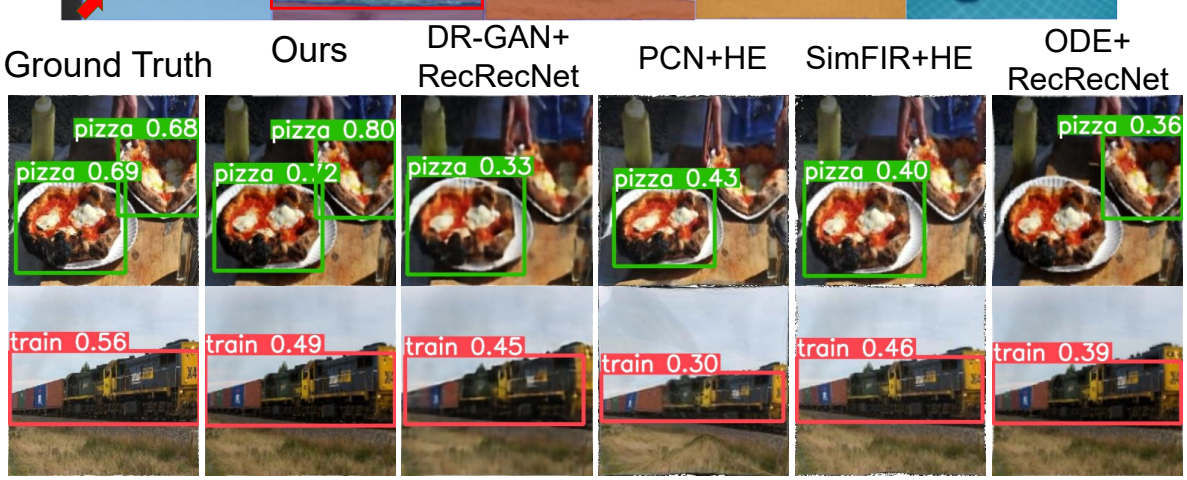

Wide-Angle Image
DeepCalib&He
Ordinal&He
PCN&He
SimFIR&Rec
DRGAN&Rec
Ours
GT

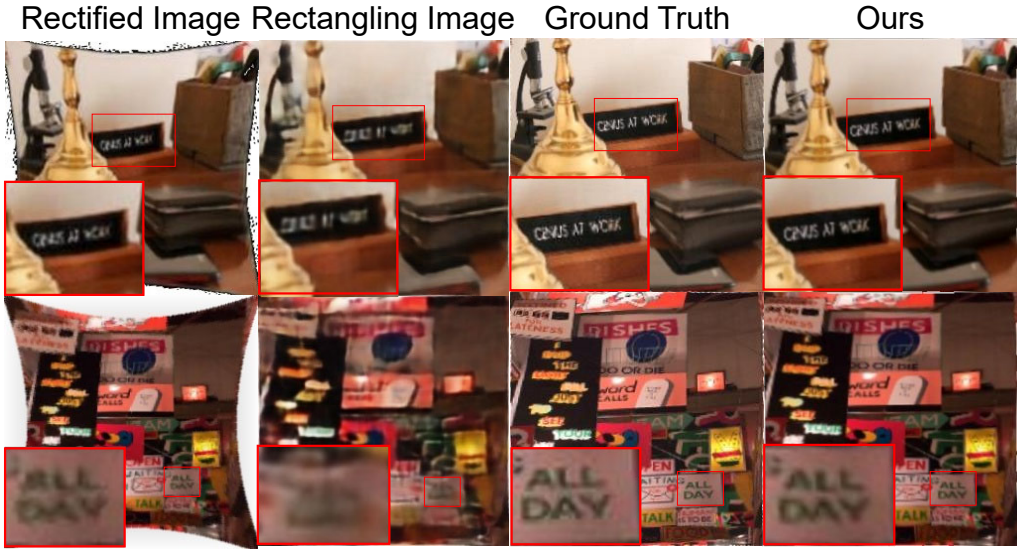

(b) Rectangling Mesh Extraction Branch
Encoder
$\mathcal{M}_{rect}$
Morphing
$\mathbf{F}_{rect}$
$\mathbf{A}_{rect}$
Spatial Attention
Backbone
Regress Module
Spatial Attention
$\mathbf{A}_{rec}$
$\mathbf{F}_{rec}$
Morphing
Encoder
$\mathcal{M}_{rec}$
(a) Rectification Mesh Extraction Branch
(c) Dynamic morphing
$\Delta\mathcal{M}_{TPS}$: Global TPS Offset
(e) TPS Differential Tr-
-ansformation Module
$\Delta\mathcal{M}_{flow}$: Local Flow Offset
(d) Flow Refinement
Conv 512 × 512
BN + ReLU
Conv 512 × 512
BN + ReLU
Conv 512 × 256
BN + ReLU
Conv 256 × 256
Sigmoid
Spatial Attention Module
$\mathcal{M}_{rigid}$
W
W
W
:Element-wise Multiplication
:Warping
:Plus
Distortion Degree
$L_{Ordinal}$
$L_{B-Spline}$
Min
Max
L_{AP}
L_{PE}
Warping results
Ground Truth

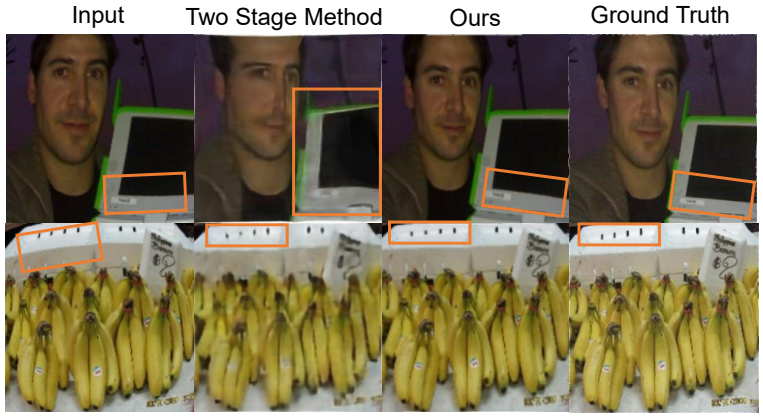

Ours
Predicted Mesh
Input

Metrics	Two-stage					Two-stage					One-stage
	ODE	DeepCalib	DR-GAN	PCN	SimFIR	ODE	DeepCalib	PCN	DR-GAN	SimFIR	Ours
	+RecRecNet					+He et al.					
PSNR↑	17.92	15.68	<u>18.09</u>	12.60	13.74	15.08	16.17	14.34	14.69	16.79	**18.59**
SSIM↑	0.50	0.41	<u>0.51</u>	0.31	0.36	0.40	0.41	0.35	0.37	0.45	**0.54**
LPIPS↓	<u>0.15</u>	0.21	0.18	0.25	0.25	0.22	0.19	0.23	0.25	0.18	**0.13**
MS-SSIM↑	0.69	0.59	<u>0.70</u>	0.45	0.59	0.53	0.54	0.44	0.47	0.61	**0.75**
Time↓ (s)	1.21	0.10	0.11	**0.02**	0.06	20.64	19.53	19.45	19.54	19.48	<u>0.04</u>
mIoU↑ (SAM)	<u>0.47</u>	0.38	0.38	0.23	0.35	0.29	0.31	0.23	0.20	0.30	**0.56**
mIoU↑ (YOLO)	<u>0.56</u>	0.55	0.45	0.42	0.51	0.44	0.49	0.40	0.33	0.51	**0.65**
mAP↑ (YOLO)	0.36	0.39	0.24	0.30	<u>0.40</u>	0.25	0.31	0.25	0.13	0.31	**0.46**


Two-stage
Ours


Ground Truth
Ours
DR-GAN+ RecRecNet
PCN+HE
SimFIR+HE
ODE+ RecRecNet
pizza 0.68
pizza 0.69
pizza 0.80
pizza 0.33
pizza 0.43
pizza 0.40
pizza 0.36
train 0.56
train 0.49
train 0.45
train 0.30
train 0.46
train 0.39


Rectified Image
Rectangling Image
Ground Truth
Ours


Input
Two Stage Method
Ours
Ground Truth