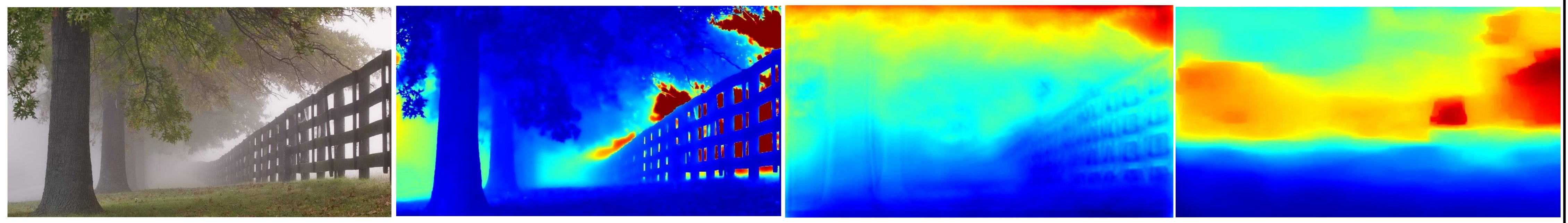
IMAGE-BASED PM2.5 ESTIMATION AND ITS APPLICATION ON DEPTH ESTIMATION

Jian Ma, Kun Li*, Yahong Han, Pufeng Du, Jingyu Yang

Tianjin University, Tianjin 300350, China

❑ Contribution

Est. PM2.5 =209.507 μg / m³



Input Ours Hourglass Network[4] Depth Transfer[7]

- An image-based method for PM2.5 real-time estimation by capturing a single image instead of carrying an expensive measurement equipment
- A depth estimation method with sparse prior and non-local bilateral kernel
- More accurate monocular depth estimation, especially in foul weather

❑ Dataset

Some captured images in our database with the ground-truth PM2.5 values

Excellent 0 ~ 35μg / m³

Good 35 ~ 75μg / m³

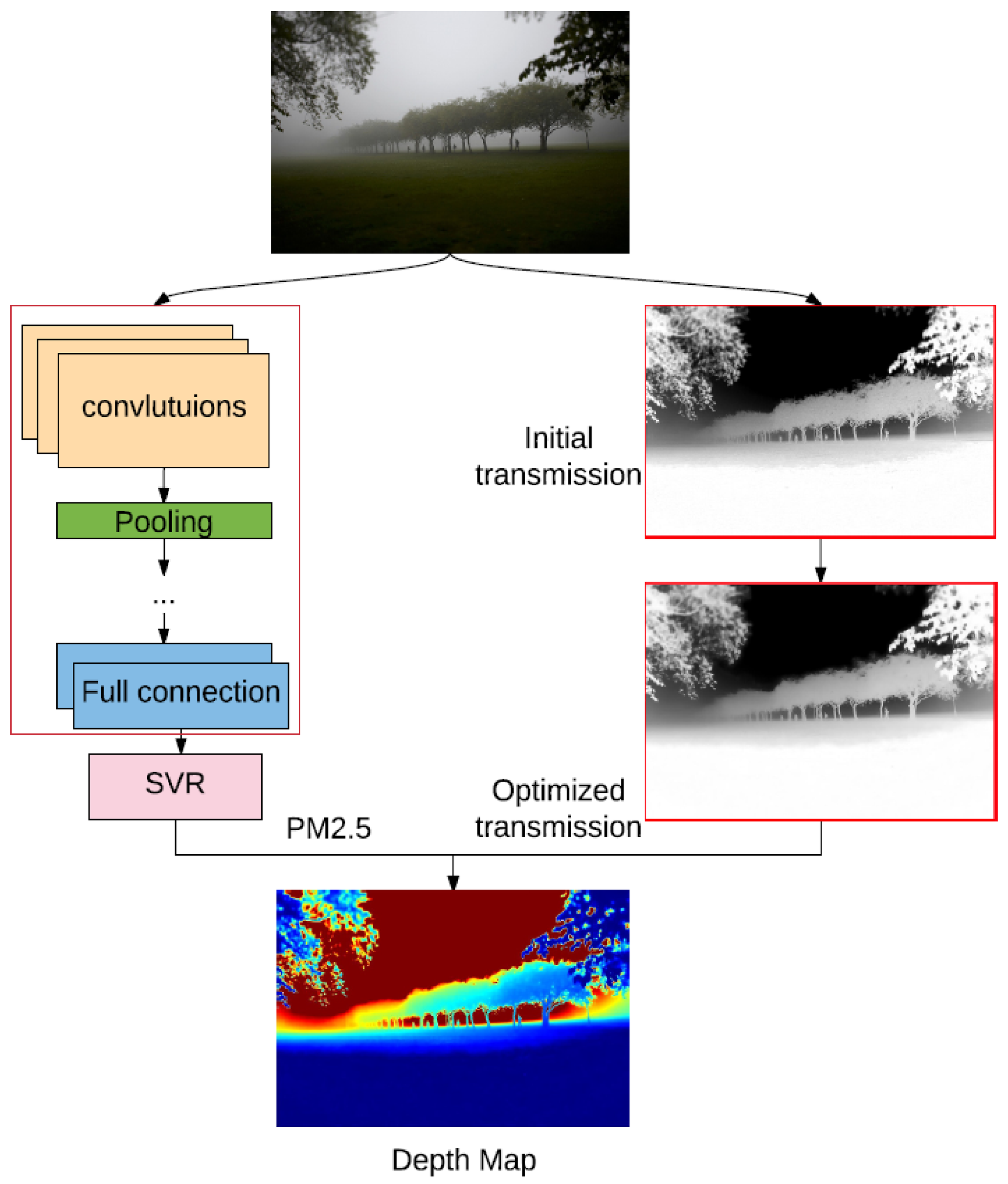
Light Pollution 75 ~ 115μg / m³

Medium Pollution 115~ 150μg / m³

Heavy Pollution 150 ~ 250μg / m³

Serious Pollution 250 ~ μg / m³

❑ Method



❑ Comparison with different kernel functions of SVR

GT	16.75	102.76	178.06	185.81	191.19	217.90	228.66	256.46	280.70
Linear	8.46	108.47	182.21	181.41	198.02	210.76	228.52	252.25	273.85
RBF	186.21	190.37	213.29	214.38	216.70	217.90	219.08	223.55	226.17
Poly-nomial	220.90	221.48	220.54	220.64	221.62	220.99	221.61	222.62	223.36

❑ Depth Estimation

- The depth can be estimated using β and $t(x)$

$$d(x) = 1 - \frac{1}{\beta} \ln t(x) \qquad (1)$$

- $t(x)$ is initialized by dark channel prior

$$\tilde{t}(x) = 1 - \omega \min_{c} \min_{y \in \Omega(x)} \frac{I^c(y)}{A^c} \qquad (2)$$

and optimized by

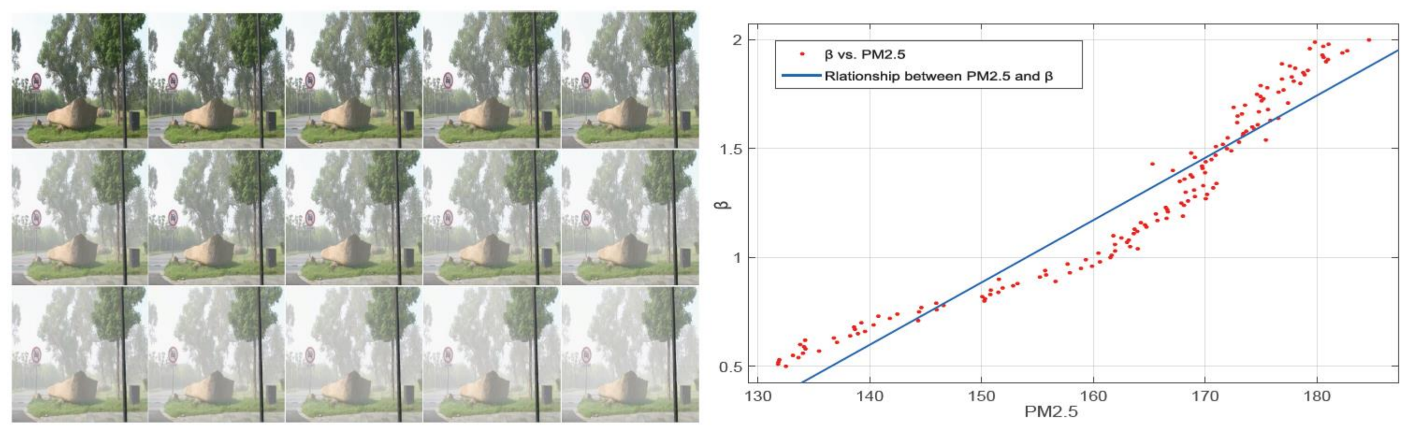
$$\sum_x \frac{(t(x) - \tilde{t}(x))^2}{\sigma^2(x)} + \lambda \sum_x \sum_{y \in N(x)} \sqrt{\alpha_{x,y}} \, \| t(x) - t(y) \|_1 \qquad (3)$$

$$\alpha_{x,y} = \exp \frac{||B_x \circ (P_x - P_y)||_2^2}{\vartheta_1^2} \qquad (4)$$

$$B_x(x,y) = \exp(-\frac{||\bar{x} - \bar{y}||_2^2}{\vartheta_2^2}) \exp(-\frac{\sum_{i \in c} ||I_x^i - I_y^i||^2}{\vartheta_3^2}) \qquad (5)$$

Initial $t(x)$ Optimized $\tilde{t}(x)$

- β is estimated using PM2.5. The relationship is learnt.

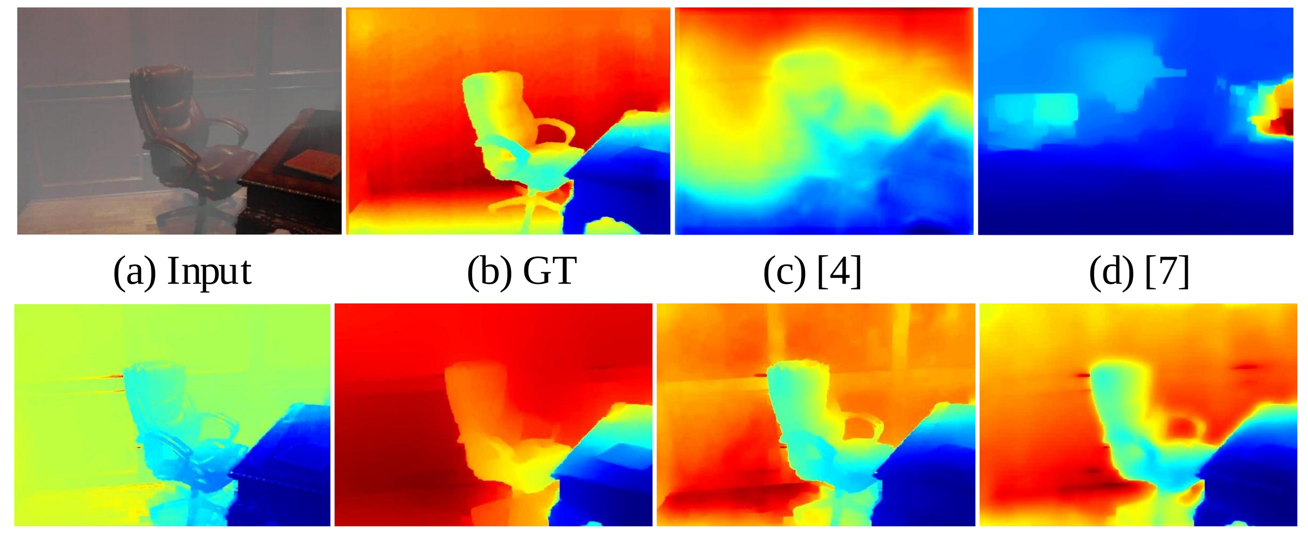


$$\beta = |aPM2.5 + b|$$

The learnt values of a and b are 0.02864 and -3.411, respectively.

❑ Results on Synthetic Dataset

- NYU dataset **Est. PM2.5 =208.402 μg / m³**

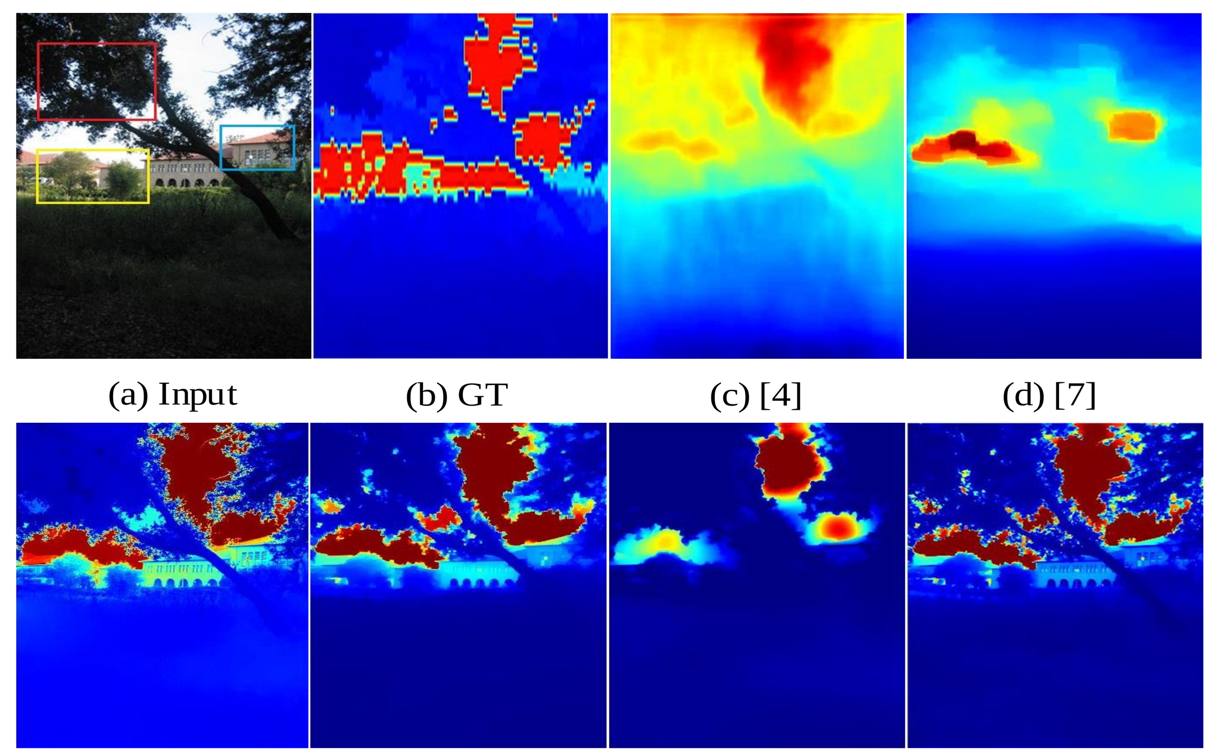


(a) Input (b) GT (c) [4] (d) [7] (e) [5] (f) [1] (g) [3] (h) Ours

Method	Rel	log10	RMS
Chen *et al.* [4]	3.6136	0.2135	0.2656
Karsch *et al.* [7]	1.5458	0.7160	0.5567
He *et al.* [5]	0.9163	0.1918	0.245
Berman *et al.* [1]	1.4717	0.1197	0.1515
Chen *et al.* [3]	0.5426	0.0978	0.1341
Our Method	**0.3308**	**0.0974**	**0.1129**

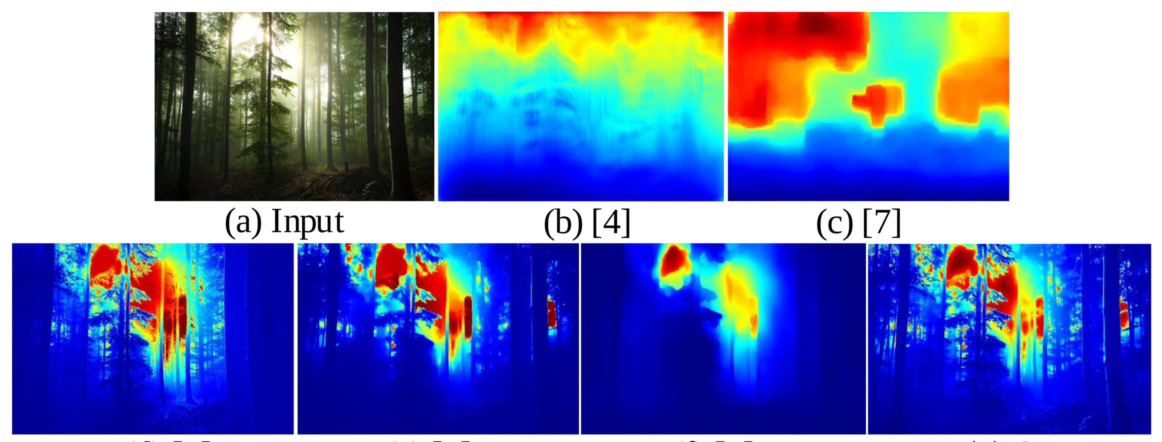
❑ Results on Real Datasets

- Make3D dataset **Est. PM2.5 =83.443 μg / m³**



(a) Input (b) GT (c) [4] (d) [7] (e) [5] (f) [1] (g) [3] (h) Ours

- Outdoor images **Est. PM2.5 =284.428 μg / m³**



(a) Input (b) [4] (c) [7] (d) [5] (e) [1] (f) [3] (g) Ours

❑ Contact: Dr. Kun Li lik@tju.edu.cn

❑ Project Home page: http://cs.tju.edu.cn/faculty/likun/projects/PM2.5