Image Dehazing

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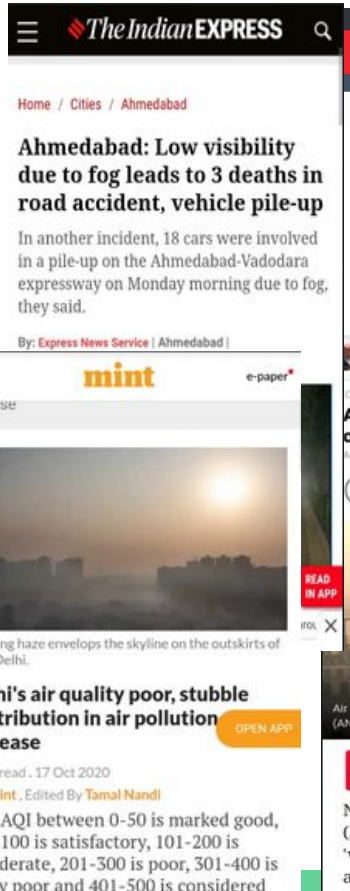
MOTIVATION


The Indian EXPRESS
Home / Cities / Ahmedabad
Ahmedabad: Low visibility due to fog leads to 3 deaths in road accident, vehicle pile-up
In another incident, 18 cars were involved in a pile-up on the Ahmedabad-Vadodara expressway on Monday morning due to fog, they said.
By: Express News Service | Ahmedabad |

mint
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Morning haze envelops the skyline on the outskirts of New Delhi.
Delhi's air quality poor, stubble contribution in air pollution increase
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Livemint , Edited By Tamal Nandi
An AQI between 0-50 is marked good, 51-100 is satisfactory, 101-200 is moderate, 201-300 is poor, 301-400 is very poor and 401-500 is considered


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High chloride content in the city's aerosols results in a foggy soup that shuts down transit in
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ANI | Updated: Dec 26, 2020, 11:42 IST
Air quality in Delhi was recorded in 'severe' category on Friday (ANI photo)
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NEW DELHI: The air quality index (AQI) in Delhi has been dipped to 'very poor' category on Saturday, according
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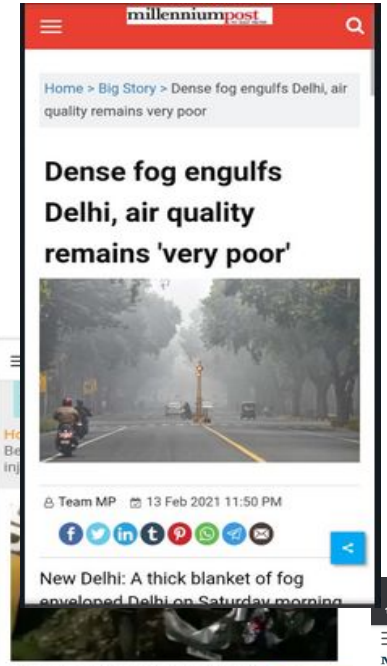
Air Quality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Dense fog engulfs Delhi, air quality remains 'very poor'
Team MP 13 Feb 2021 11:50 PM
New Delhi: A thick blanket of fog
Circle inspector of Dhupguri and his team
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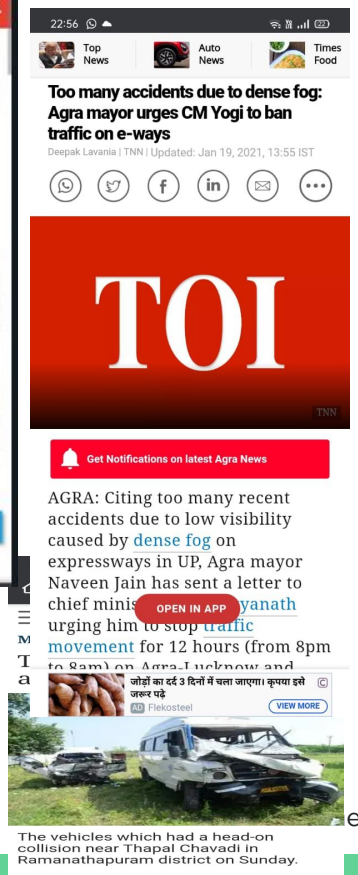
Road accident in West Bengal's Jalpaiguri due to fog: 13 dead, 18 injured
1 min read . 20 Jan 2021
Staff Writer
After getting information, police reached the spot and started rescuing the victims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Too many accidents due to dense fog: Agra mayor urges CM Yogi to ban traffic on e-ways
Deepak Lavania | TNN | Updated: Jan 19, 2021, 13:55 IST
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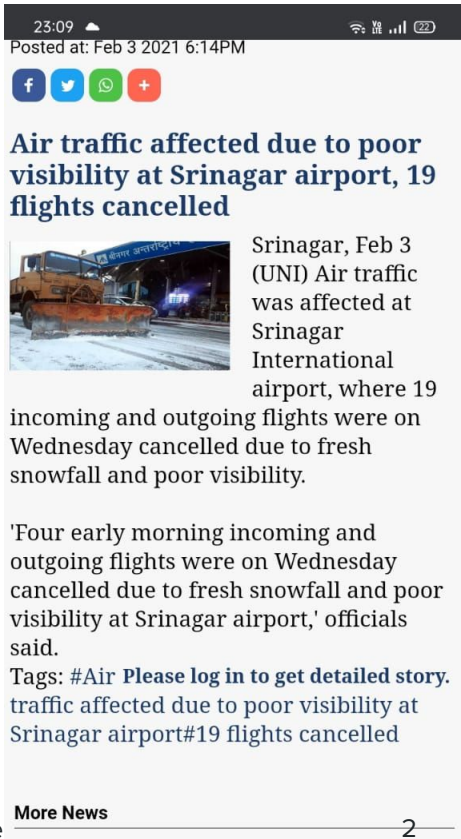
AGRA: Citing too many recent accidents due to low visibility caused by dense fog on expressways in UP, Agra mayor Naveen Jain has sent a letter to chief minis yanath urging him to stop traffic movement for 12 hours (from 8pm
OPEN IN APP
The vehicles which had a head-on collision near Thapal Chavadi in Ramanathapuram district on Sunday.


23:09
Posted at: Feb 3 2021 6:14PM
Air traffic affected due to poor visibility at Srinagar airport, 19 flights cancelled
Srinagar, Feb 3 (UNI) Air traffic was affected at Srinagar International airport, where 19 incoming and outgoing flights were on Wednesday cancelled due to fresh snowfall and poor visibility.
'Four early morning incoming and outgoing flights were on Wednesday cancelled due to fresh snowfall and poor visibility at Srinagar airport,' officials said.
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Introduction

Image quality is of prime importance for many applications, but lot of factors contribute to make a image among which one of the keys is contrast. The project aims to understand the process of hazing through atmosphere scattering model, study dehazing algorithms, evaluate performance of different algorithms and propose an original architecture which would provide good and fast performance outdoors.

The are many approaches taken to solve the image hazing problem, such as polarization, contrast enhancement, Dark channel prior etc., but our focus will be to solve the problem using deep learning method.

Tel aviv univ.

Problem definition

- ➔ To Combat the problem of loss of contrast and noise in images
- ➔ Despite availability of many Dehazing algorithms the is no common comparison on performance on real haze images.
- ➔ Integrate the model in commonly used machine vision pipeline to provide better performance, so as to combat the decision making dilemma faced by many SOTA machine vision problems.

RANK	MODEL	PSNR ↑	SSIM
1	FFA-Net	35.77	0.9846
2	GCANet	30.23	0.98
3	GMAN	20.53	0.8081
4	Deep DCP	19.25	0.832

paperswithcode

Literature review

Datasets

[1] RESIDE

- REalistic Single Image DEhazing
- Aimed at evaluating performance of single image Dehazing algorithms.
- The RESIDE:V0 provides about 313,000 synthetic outdoor hazy images
- Presents innovative set of evaluation techniques besides PSNR and SSIM, also employs no reference metrics such as BLIINDS-II and human subjective score for comparison (clearness & authenticity) fitted on Bradley-terry model.
- Provides a benchmark for single image dehazing
- Presents comparison and limitations of many SOTA, such as DehazeNet, AOD-Net, DCP etc

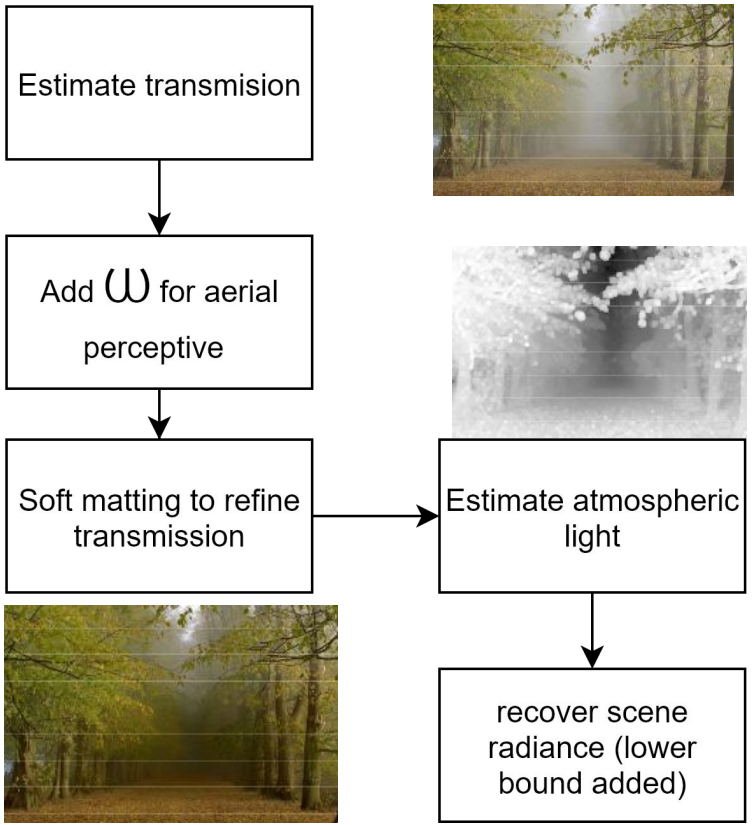
[6] O-haze

- Outdoor scenes database (named O-HAZE) composed of pairs of real hazy and corresponding haze-free images.
- O-HAZE is used to compare a representative set of state-of-the-art dehazing techniques, using traditional image quality metrics such as PSNR, SSIM and CIEDE2000.
- The few datasets that are currently considered, both for assessment and training of learning-based dehazing techniques, exclusively rely on synthetic hazy images.
- This reveals the limitations of current techniques, and questions some of their underlying assumptions.

Models

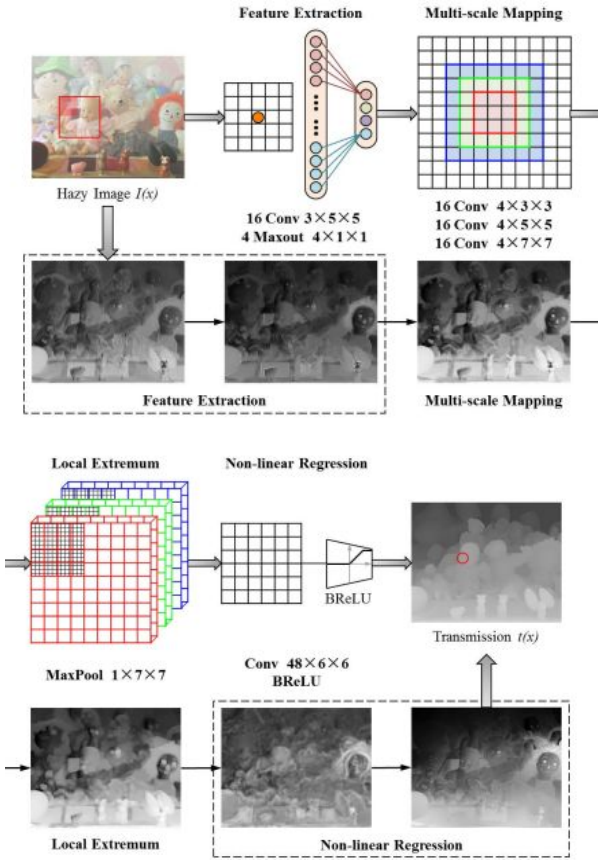
[9] Dark Channel Prior

- DCP is a kind of statistic for haze free images, based on assumption that local patches in haze free images contain some pixels which have very low intensities in at least one color channel.
- Uses the atmosphere scattering model as a starting point I(x)=J(x)t(x)+A(1-t(x)); t(x)=e^(-β.d(x))
- DCP is based on digital imaging principle so it is simple and low cost approach.
- Has shortcomings such as colour distortion, detail loss and computational complexity

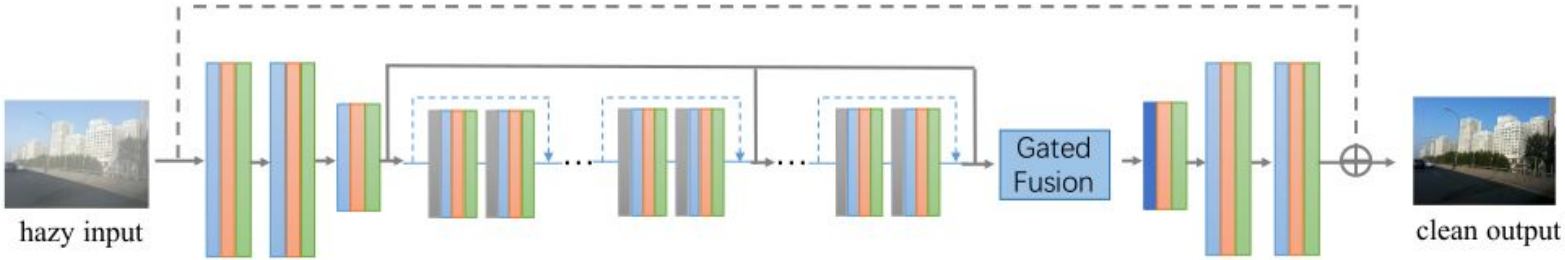


[10] Dehaze Net

- DehazeNet adopts Convolutional Neural Networks (CNN) based deep architecture, whose layers are specially designed to embody the established assumptions/priors in image dehazing.
- Layers of Maxout units are used for feature extraction, which can generate almost all haze-relevant features.
- Uses a novel nonlinear activation function in DehazeNet, called Bilateral Rectified Linear Unit (BReLU), which is able to improve the quality of recovered haze-free image.
- Drawback - dehazing sky region and the scene objects which are inherently similar to the atmospheric light (such as the fair-skinned complexion)



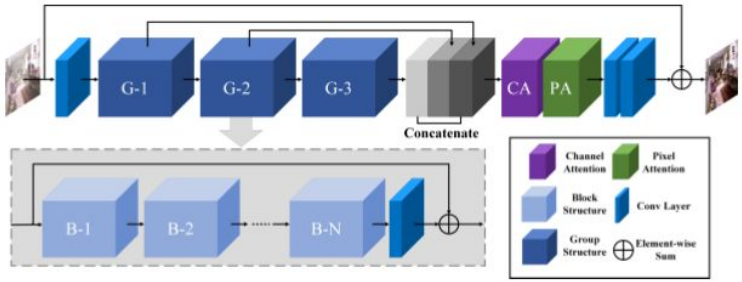
[3] Gated Context Aggregation Network

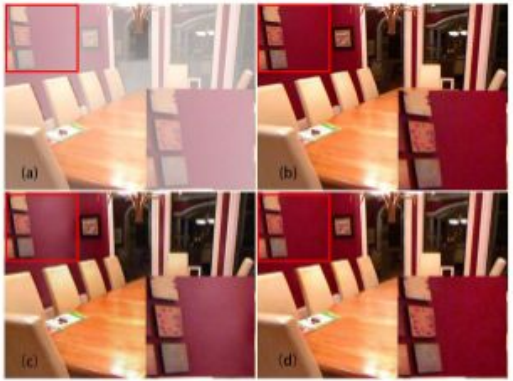


- Adopts smoothed dilated convolution to avoid loss of spatial resolution in subsampling
- Uses a gated fusion sub-network to fuse high level semantic feature maps at all scales
- Mean square error loss, adam optimizer, trained for 100 epochs on RESIDE dataset
- Obtains better performance in terms of PSNR & SSIM when compared to DCP, AOD-Net, Dehazenet.

[4] Feature Fusion Attention Network

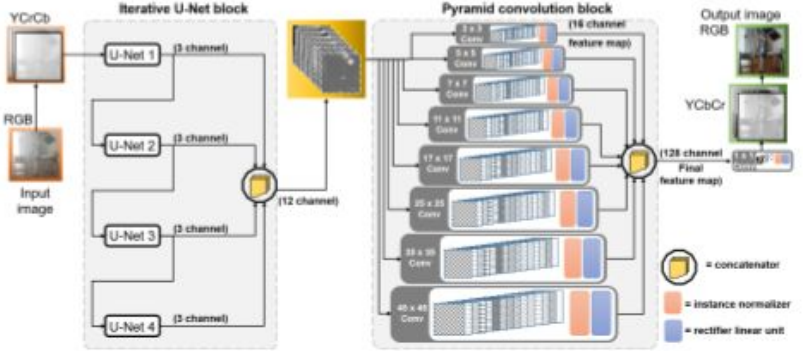
- A novel Feature Attention (FA) module combines Channel Attention with Pixel Attention mechanism.
- Giving more weight to important features. This structure can also retain the information of shallow layers and pass it into deep layers.
- Uses MSE loss function and RESIDE dataset.
- FFA network has a powerful advantage in the restoration of image detail and color fidelity.
- Shortcoming - Complexity of network and cannot be used for real time application.





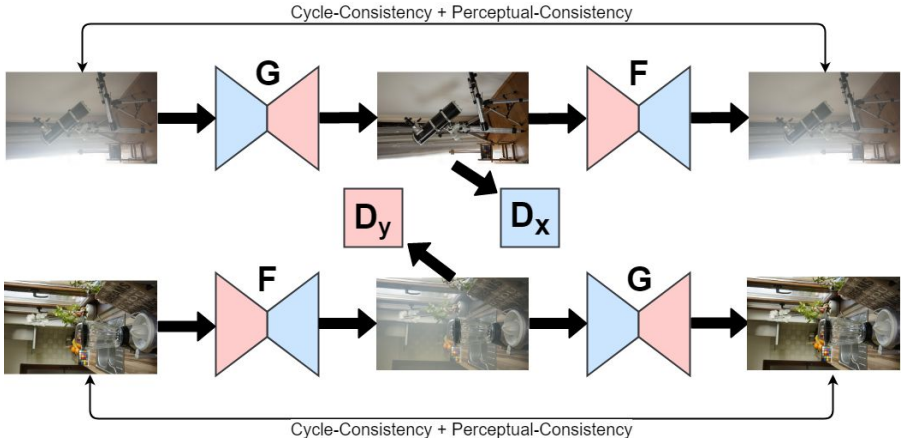
[6] Back Projected Pyramid Network

- A novel technique named pyramid convolution is introduced for dehazing to obtain spatial features of multiple scales structural information.
- UNet block for image dehazing tasks to make the generator learn different and complex features of haze without the loss of local and global structural information.
- Extensive experimentation is done on four contemporary challenging datasets, namely I-Haze and O-Haze datasets of NTIRE 2018 challenge, Dense-haze dataset
- Uses a combination of MSE (L2 loss), adversarial loss Ladv, content loss Lcon, and structural similarity loss LSSIM.
- Drawback - color preservation and seamless color cast



[5] Cyclic gan

- CycleGAN combines cycle-consistency and perceptual losses in order to improve the quality of textural information recovery and generate visually better haze-free images.
- After obtaining low-resolution outputs from the network, we utilize the Laplacian pyramid to upscale the output images to the original resolution unlike other models which display the output in lower resolution.
- Trained with NYU-Depth, I-HAZE, and O-HAZE datasets



Metrics

Need for different metrics

Traditional quality estimation metrics are :

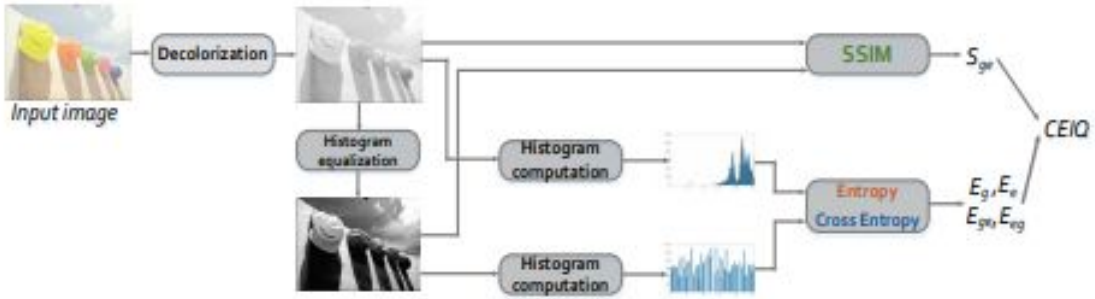
- PSNR- peak signal to noise ratio
- SSIM- structural similarity index measure

  Both these need reference image and fail to provide the specificity required for dehazing problems

- The training of deep learning models generally requires ground truth images but the during prediction process i.e. evaluating a new image there is absence of ground truth image.
- NR IQA help in quantifying image quality when there is no reference to compare.

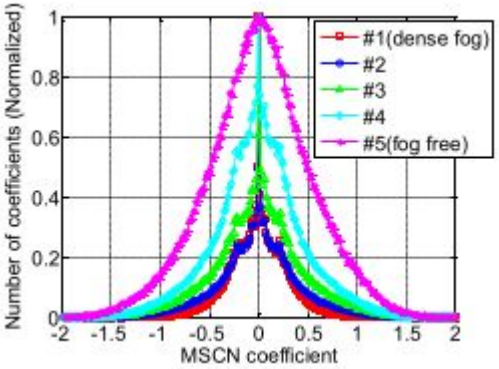
[11] Contrast Distorted Image Quality

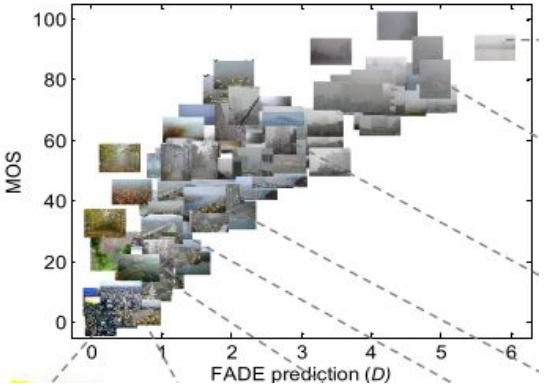
- A simple but effective metric for predicting quality of contrast-altered images based on the fact that a high-contrast image is often more similar to its contrast enhanced image.
- Experiments on four publicly available databases validate the superiority and efficiency of the proposed technique.
- Uses 5 features and learn a regression module to quantize the image quality - structural-similarity index (SSIM) , histogram based entropy and cross entropy for the original image and the enhanced one respectively.



[2] Fog Aware Density evaluator

- Predicts visibility of a foggy scene from a single image without reference
- Based on NSS Model
- Fog Aware features such as variance, sharpness, colorfulness etc derived from a local patch.
- Features are fitted to a MVG, level of fog is determined by the Mahalanobis-like distance between hazy image and MVG model extracted from a corpus of 500 fog free images.
- FADE is compared to human subjective study





Objectives

- Study literature on SOTA dehazing algorithms (7 Feb - 10 Feb)
- Develop different SOTA models on tensorflow and pytorch (11 Feb - 20 Feb)
- Quantize the quality of an image with reference and non-referential image. (21 Feb - 24 Feb)
- Performance comparison of common metrics (25 Feb - 28 Feb)
- Compare various models and study their shortcomings. (1Mar - 5 Mar)
- Develop a novel model (5 Mar - 20 Mar)
- Learning various preprocessing techniques and hyperparameter tuning to improve the overall model performance. (21 Mar - 31 Mar)
- Iterate over different model blocks to improve performance and justify need for each block. (1 Apr - 15 Apr)

Methodology

- The current standard for image dehazing is studied and the algorithms are implemented using Python programming language, using deep learning frameworks such as TensorFlow and PyTorch.
- The algorithms are modified so that they output a common metric such as FADE (Fog Aware Density Evaluator) and compared.
- The learning from the present SOTA algorithms are put in developing a new architecture.
- The new model is trained on datasets such as RESIDE and O-Haze

References

[1] B. Li et al., "Benchmarking Single-Image Dehazing and Beyond," in IEEE Transactions on Image Processing, vol. 28, no. 1, pp. 492-505, Jan. 2019, doi: 10.1109/TIP.2018.2867951.

[2] L. K. Choi, J. You and A. C. Bovik, "Referenceless Prediction of Perceptual Fog Density and Perceptual Image Defogging," in IEEE Transactions on Image Processing, vol. 24, no. 11, pp. 3888-3901, Nov. 2015, doi: 10.1109/TIP.2015.2456502.

[3] D. Chen et al., "Gated Context Aggregation Network for Image Dehazing and Deraining," 2019 IEEE Winter Conference on Applications of Computer Vision (WACV), Waikoloa Village, HI, USA, 2019, pp. 1375-1383, doi: 10.1109/WACV.2019.00151.

[4] Xu Qin, Zhilin Wang, Yuanchao Bai, Xiaodong Xie, Huizhu Jia, “FFA-Net: Feature Fusion Attention Network for Single Image Dehazing,” arXiv:1911.07559

[5] D. Engin, A. Genc and H. K. Ekenel, "Cycle-Dehaze: Enhanced CycleGAN for Single Image Dehazing," 2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), Salt Lake City, UT, 2018, pp. 938-9388, doi: 10.1109/CVPRW.2018.00127.

[6] Ayush Singh, Ajay Bhave, Dilip K. Prasad, “Single image dehazing for a variety of haze scenarios using back projected pyramid network,” arXiv:2008.06713 [eess.IV]

[7] V. Vishal, N. Sharma and M. Singh, "Guided unsupervised desmoking of laparoscopic images using cycle-desmoke", OR 2.0 Context-Aware Operating Theaters and Machine Learning in Clinical Neuroimaging, pp. 21-28, 2019.

[8] Xiang Chen, Yufeng Li, Yufeng Huang, “DehazeZoo” ,https://github.com/cxtalk/DehazeZoo ,(26/01/2021)

[9] K. He, J. Sun and X. Tang, "Single Image Haze Removal Using Dark Channel Prior," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 33, no. 12, pp. 2341-2353, Dec. 2011, doi: 10.1109/TPAMI.2010.168.

[10]B. Cai, X. Xu, K. Jia, C. Qing and D. Tao, "DehazeNet: An End-to-End System for Single Image Haze Removal," in IEEE Transactions on Image Processing, vol. 25, no. 11, pp. 5187-5198, Nov. 2016, doi: 10.1109/TIP.2016.2598681.

[11] Y. Liu and X. Li, "No-Reference Quality Assessment for Contrast-Distorted Images," in IEEE Access, vol. 8, pp. 84105-84115, 2020, doi: 10.1109/ACCESS.2020.2991842.

Thank you

-https://github.com/abubakrsiddq/ImageDehazing