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Implementation of Video-dehazing based on AOD-Net using Docker on Jetson Nano

Challa Gopala Krishna Reddy
Electronics and Communication Department
National Institute of Technology Warangal
Warangal, India
cg21ecb0b09@student.nitw.ac.in

Shrikar Kaveti
Electronics and Communication Department
National Institute of Technology Warangal
Warangal, India
ks21ecb0b21@student.nitw.ac.in

Dr. Ravi Kumar Jatoth
Electronics and Communication Department
National Institute of Technology Warangal
Warangal, India
ravikumar@nitw.ac.in

ABSTRACT

- Haze and Fog are weather conditions which are highly prevalent in many regions across the world.
- Haze lead to degradation of human vision as well as visual quality in images and videos.

Fig. 1. Robotic Arm

Fig. 2. Drones

Fig. 3. Self Driving Car

RELATED WORK

$$I\,(x) = J\,(x)\,t(x) + A\big(1 - t(x)\big) \quad (1)$$

Where $I(x)$ is observed hazy image, $J(x)$ is scene radiance, A is global atmospheric light and, $t(x)$ is transmission matrix is defined as

$$t(x) = e^{-\beta d(x)} \quad (2)$$

where, beta is scattering coefficient of atmosphere and $d(x)$ denotes distance between camera and object

$$J(x) = \frac{1}{t(x)}\,I(x) - A\,\frac{1}{t(x)} + A \quad (3)$$

$$J(x) = K(x)\,I(x) - K(x) + b, where$$

$$K(x) = \frac{\frac{1}{t(x)}(I(x)-A)+(A-b)}{I(x)-1} \quad (4)$$

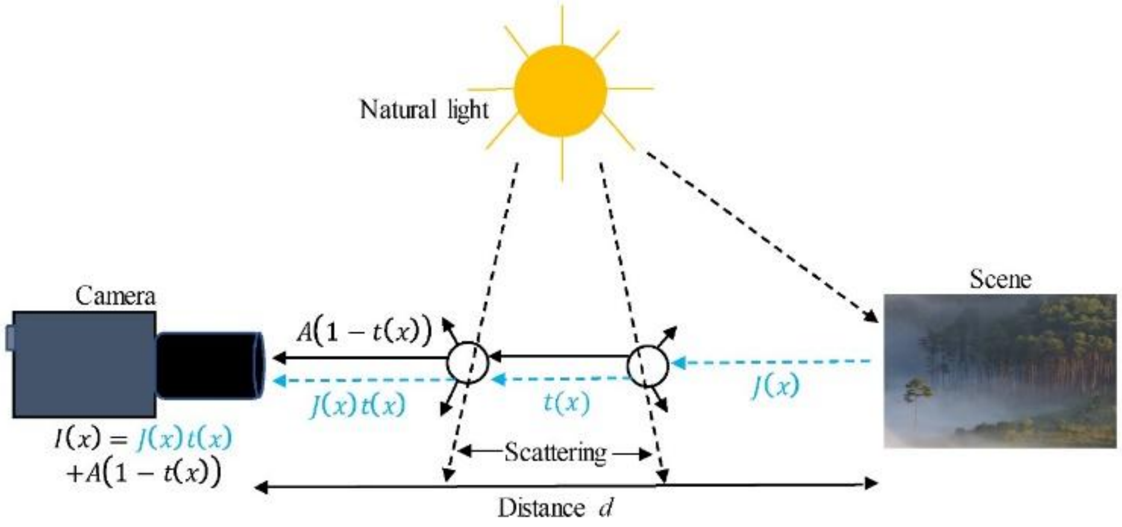

Fig. 4. Atmospheric Light Scattering Model

DOCKER

- Docker is an platform which is used for developing, shipping and running applications. It packages the application with everything the application needs such as code, libraries, etc into a container.
- Containers are independent and can run on any computer, making it easy to share and deploy software quickly.

Fig. 5. Deploying Software using Docker Image

NETWORK DESIGN

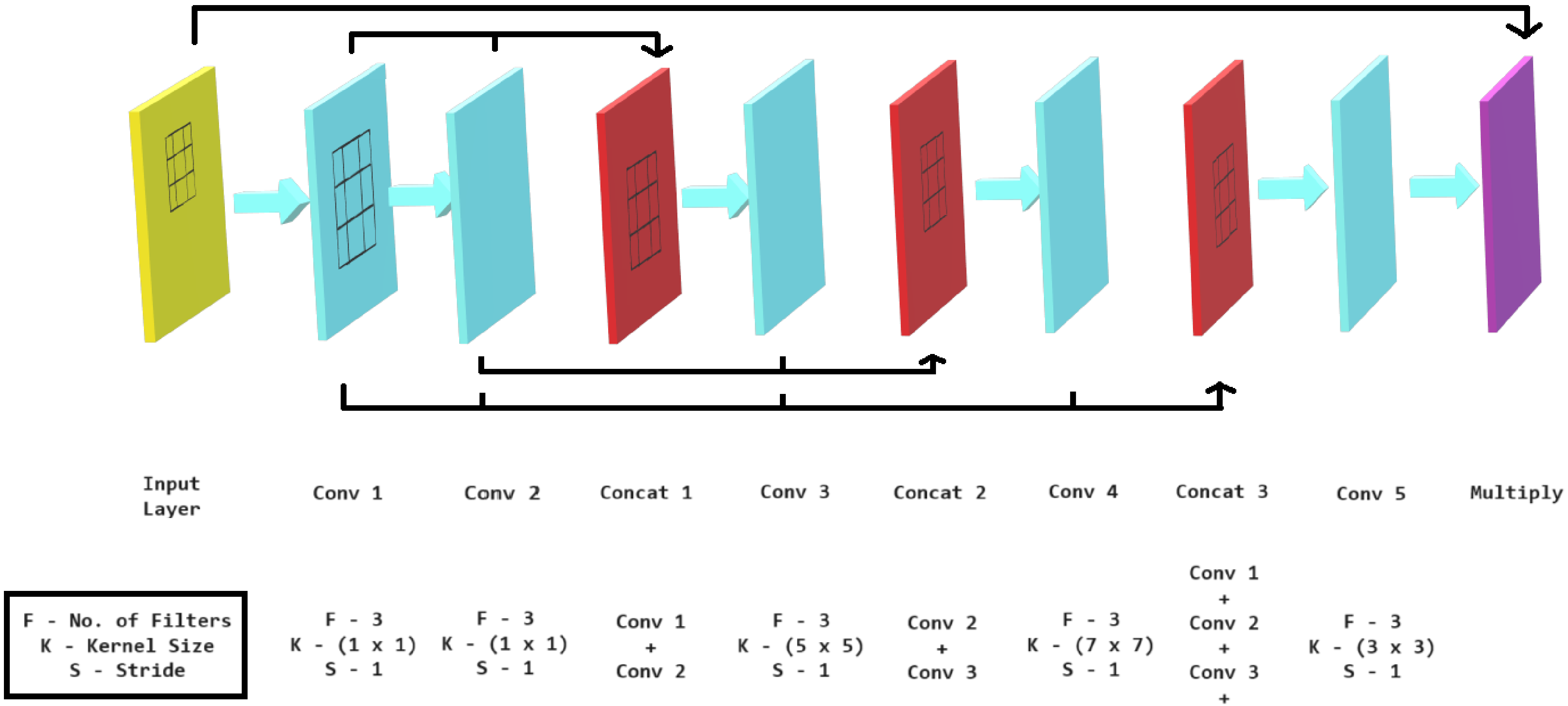

Fig. 6. Network Design

NETWORK DESIGN

Necessity of K factor Module

- Most Machine learning models used for generating the dehazed image require very high computational power.
- These model use Up and Down sampling or Image denoising to generate the dehazed image because of the requirement for high computation it is difficult for the model to run in real time and can be run on portable devices.
- The K Factor is calculated using the image atmospheric light and depth of the Image as given the Atmospheric Scattering Model which makes it easy to model and computationally light weight.

Necessity of Light Weight Model

- Running the Machine learning model in real time is necessary for certain critical applications such as Self Driving Cars.
- Hence, for reducing computational cost or limiting computational cost CNN model is chosen instead of GAN models or Transformers which can produce a better output Image quality compared to CNN models.

NETWORK DESIGN

Layer Name	Layer	No. of Filters	Kernal Size	Stride
Conv 1	Convolution 2D	3	1 x 1	1
Conv 2	Convolution 2D	3	1 x 1	1
Conv 3	Convolution 2D	3	5 x 5	1
Conv 4	Convolution 2D	3	7 x 7	1
Conv 5	Convolution 2D	3	3 x 3	1

Table I. CNN Hyperparameters

Hyperparameters	Value
Stride	1
Padding	same
Activation	ReLU
Neural Network Bias	True
Kernal Initializer	Random (Normal Distribution)
Kernal Regularizes	L2 (Ridge Regression)
Batch Size	1
Epochs	25
Callback	Reduce Learning Rate on Plateau
Optimizer	Adams
Loss Function	MSE
Model Loss	0.030715337023139
Model Accuracy	89.92100358009338 %

Table II. Network Hyperparameters

EVALUATION

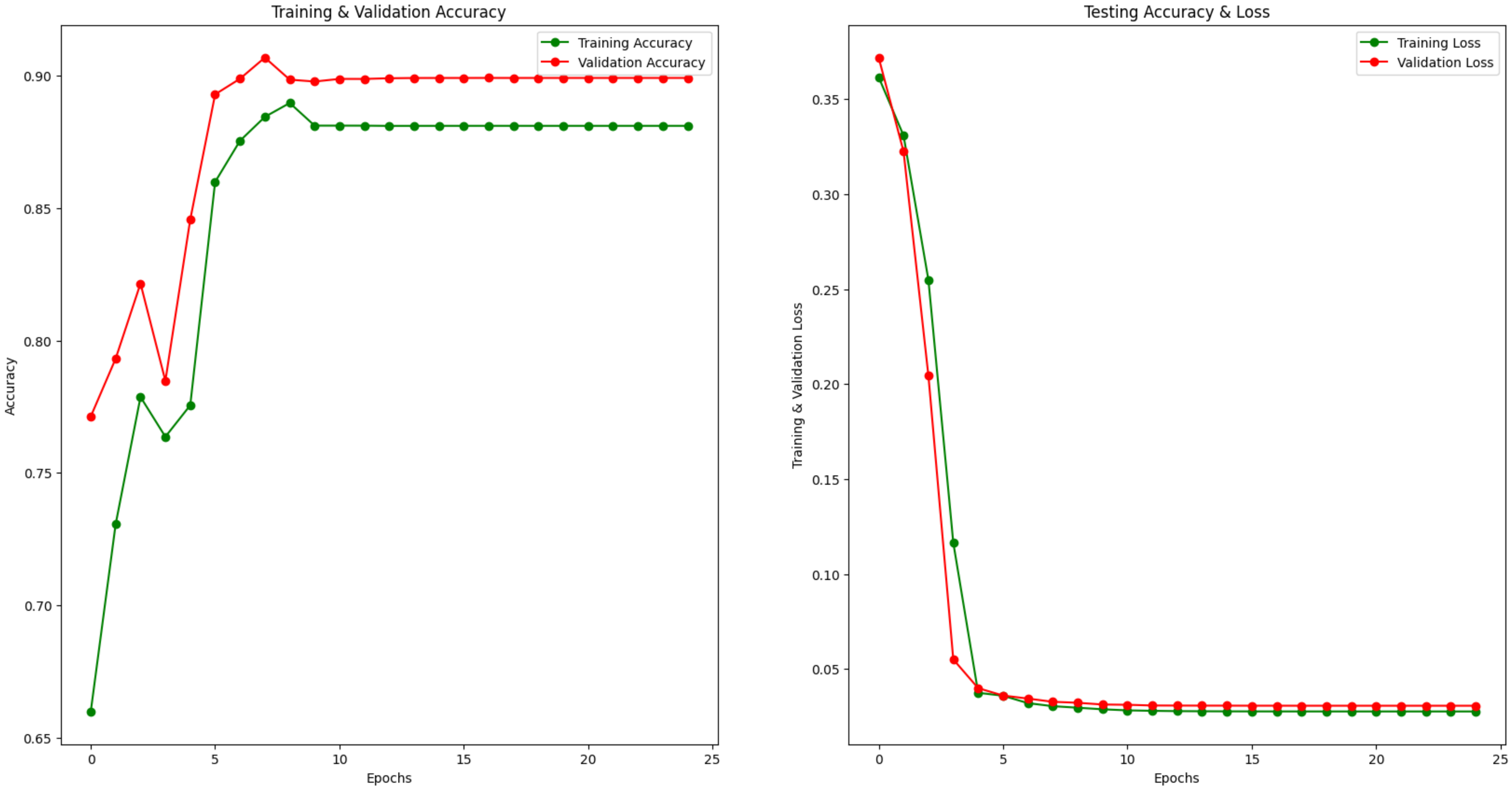

Fig. 7. Training Curve

EVALUATION

Haze Image Datasets

Fig. 8. REVIDE Dataset

Fig. 9. HazeRD Dataset

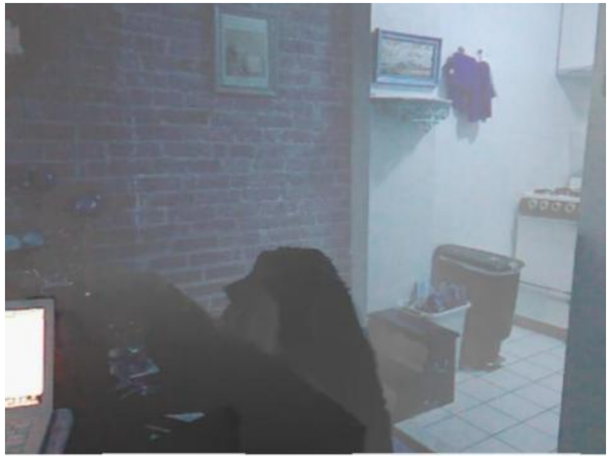

Fig. 10. NYU2 Dataset

EVALUATION

(A) (B) (C) (D)

Fig. 11. Dehazing of Synthetically generated Haze Images
(A, B) Input Haze Images (Top Row), Output Dehazed Image (Below Row)
Dehazing of Real Haze Images
(C, D) Input Images (Top Row), Output Dehazed Image (Below Row)

EVALUATION

Fig. 12. Real Video Dehazing

EVALUATION

Visibility	50m	100m	200m	500m	1000m
Weather Condition	Dense	Thick	Thick	Moderate	Light
Scattering Coefficient (Beta)	78.2	39.1	19.6	7.82	3.91
PSNR	12.8007	17.5181	21.1731	21.4665	20.909
SNR	7.5038	12.2212	15.8762	16.1692	15.612

Table III. Visual range and corresponding scattering coefficient, PSNR, SNR and Weather Condition

AOD-Net	Average	Max	Min
PSNR	15.8819	21.839	13.5945
SSIM	0.51909	0.89	0.43
RMS	0.2835	0.3621	0.1401

Table IV. AOD-Net Statistics (PSNR, SSIM, RMS)

Metrics	On-Device	Docker
Avg. Time	0.357 ms	0.48 ms

Table V. Comparison of Average Prediction time for AOD-Net running on Device and Docker

HARDWARE IMPLEMENTATION

- CPU - Quad-core ARM Cortex-A57 MPCore processor
- GPU - 128-core NVIDIA Maxwell architecture GPU
- RAM – 4 GB
- Power Usage – 10 Watts

Fig. 13. Nvidia Jetson Nano Developer Kit

RESULT

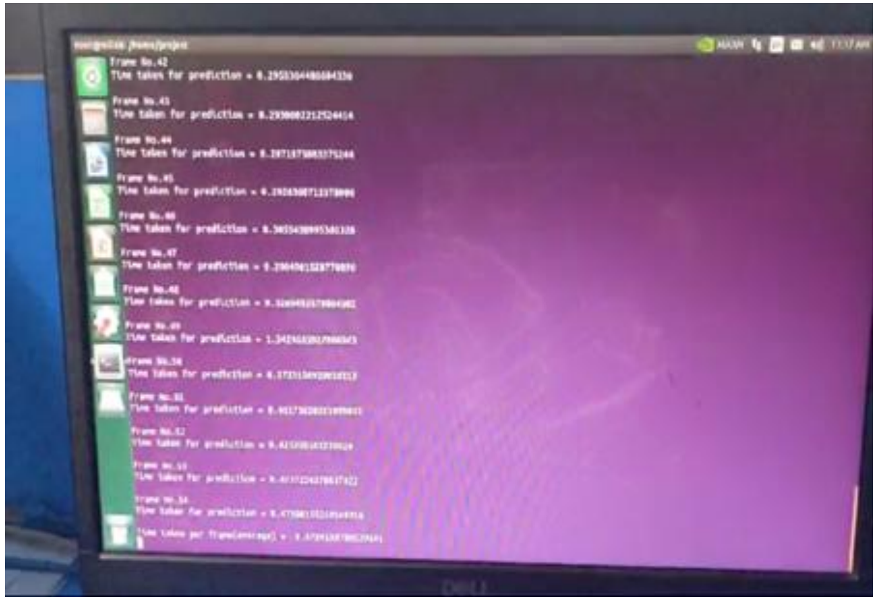

Fig. 14. Model Running in the Docker (Displaying the Prediction time for Each Frame)

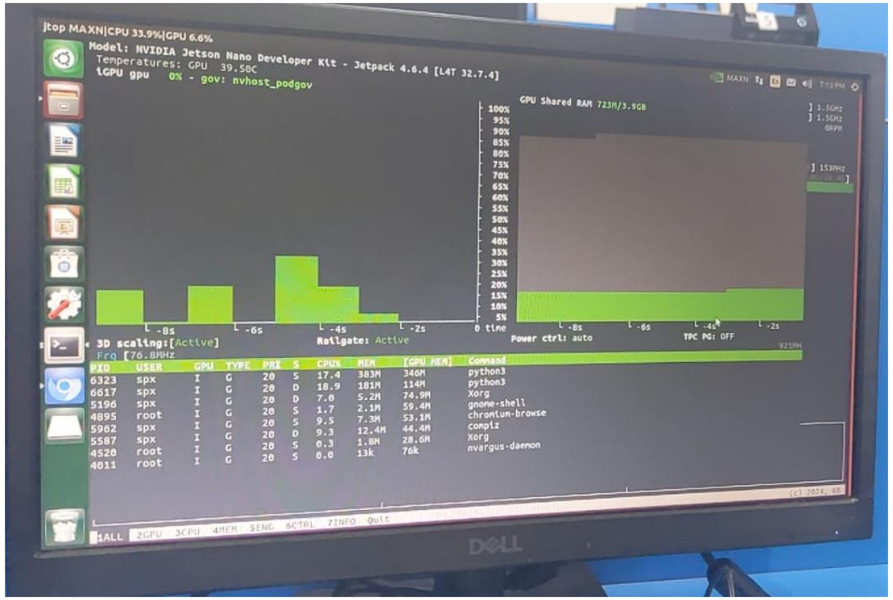

Fig. 15. GPU Utilization and Memory Consumption while running in docker

Thank You