COLORSAR

Team Members

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PROBLEM SATEMENT

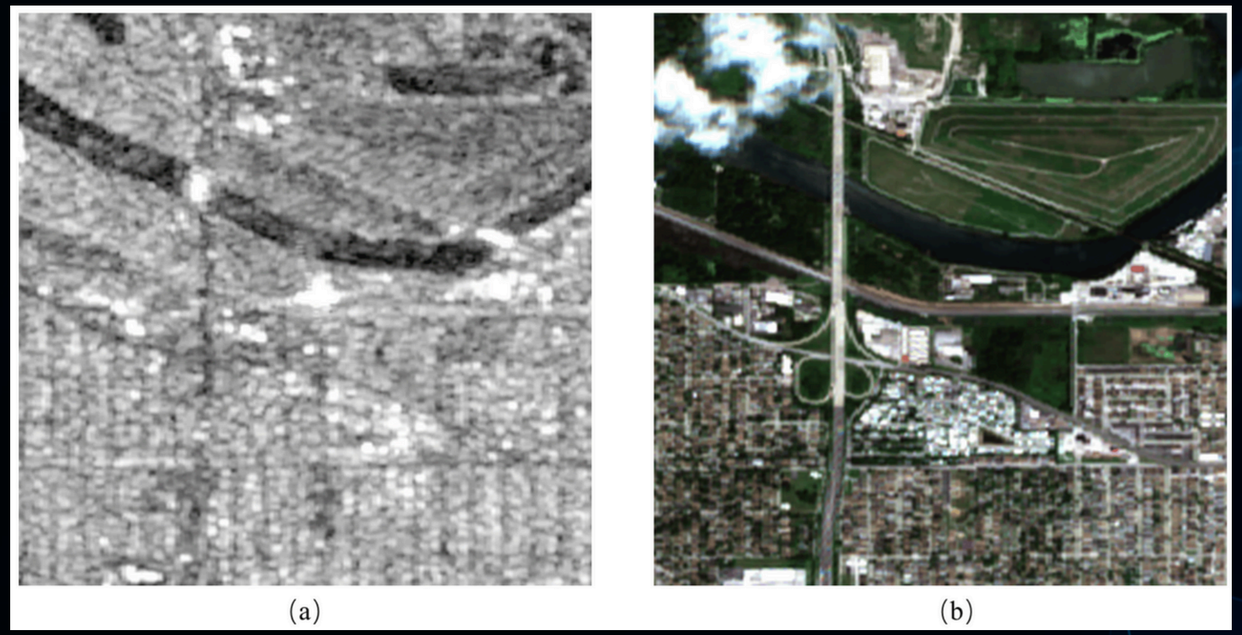
Synthetic Aperture Radar(SAR) Image Colorization for Comprehensive Insight using Deep Learning Model

SAR Image

- Grayscale
- Lack in Standard color information

Need of SAR Colorization

- Enhanced feature interpretation & analysis in weather-independent conditions
- Critical applications in geological, environmental, and urban monitoring



PREVIOUS WORK AND NOVELTY

U-Net Limitations:

- Lacks domain-specific transformation and contextual depth for SAR colorization.

GANs Limitations:

- Unstable training, computationally intensive, prone to mode collapse.

Fully Convolutional Networks (FCN)

Limitations:

- Poor spatial preservation and weak contextual mapping.

Our Approach's Advantages:

- Domain-specific(Synthetic Aperture Radar (SAR)) optimization
- Robust two-stage training methodology
- Advanced Lab color space conversion
- Improved interpretability of SAR images

METHODOLOGY

Encoder

- ResNet50
- DenseNet121

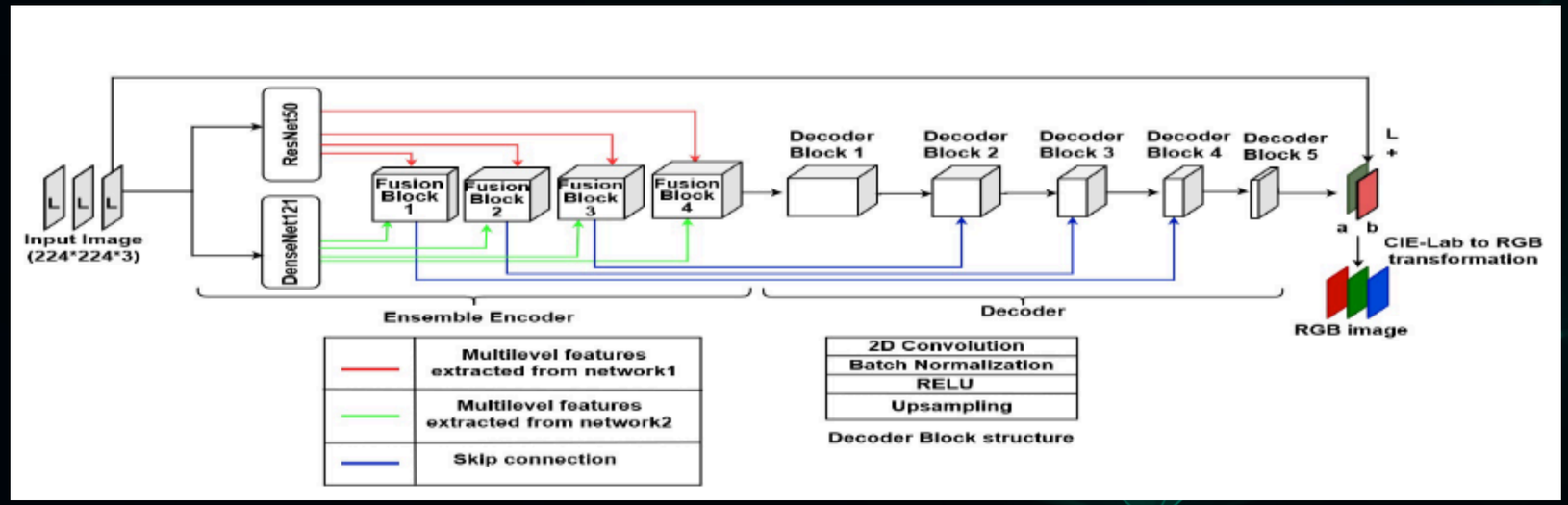
Fusion Block

$$Conc.\,Fusion = [F_{resnet}; F_{densenet}]$$

Decoder

- 2D Convulation
- Batch Normalization
- ReLu
- Upsampling

Ensemble encoder - decoder with fusion block



Evaluation Metric

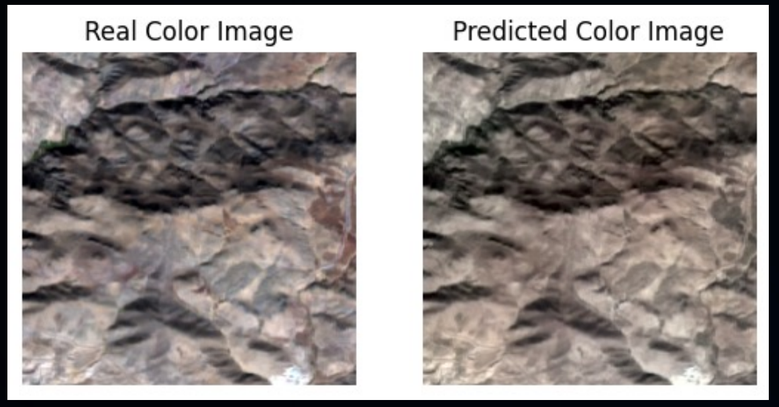
$$SSIM(x,y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$

$$PSNR = 10log_{10}(\frac{MAX_i^2}{MSE})$$

Loss Function: MSE

$$Loss = \frac{1}{N}\sum_{i=1}^{N}\left[\left(a_{pred}^i - a_{true}^i\right)^2 + \left(b_{pred}^i - b_{true}^i\right)^2\right]$$

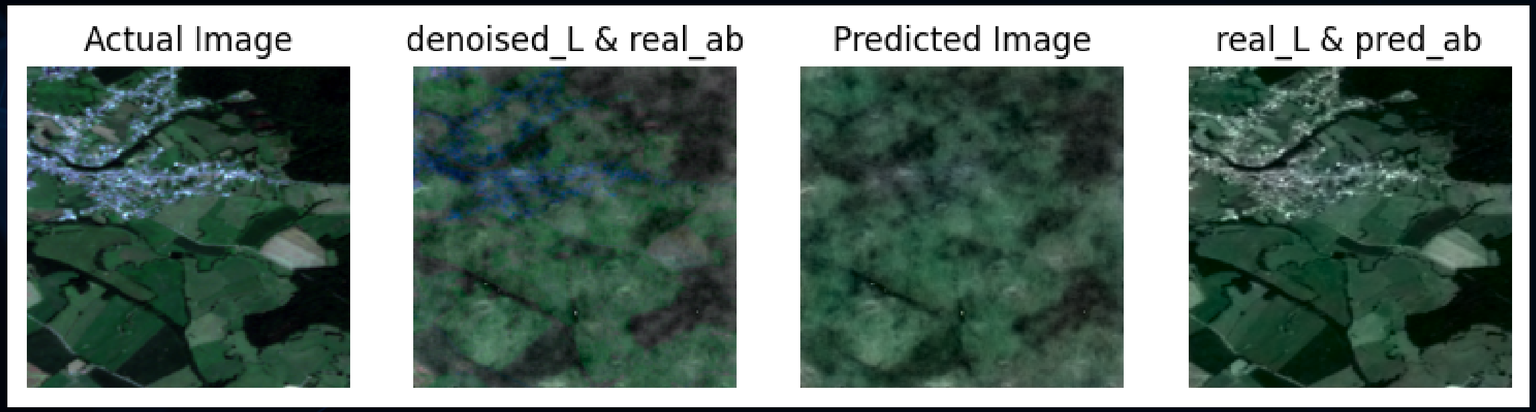
EXPERIMENTAL SETTINGS AND RESULT



Training - 1

L channel - Optical Image
a, b - Optical Image

This is highly accurate, showing that this model really does capture the underlying color information.



Key Insight : We observed that green color is more dominant in the a and b channel predicted by the model, while other colors are less dominant in the a and b channel.

Training - 2

L channel - Denoised SAR Image
a, b - Optical Image

The color prediction is good but the results as a whole are not exactly as the originals due to the noise introduced in the L channel. That noise has impacted the level of structural definition preserval quality of the images, which are less accurate

INDIVIDUAL CONTRIBUTIONS

Aditya Bajpai

Defined and implemented evaluation metrics to assess the accuracy and quality of colorized images, ensuring realistic and consistent results. Explored DnCNN and its application of Gaussian denoising techniques within our project.

Nishant Verma

Designed and implemented the encoder-decoder architecture for the model. The encoder extracted key spatial and texture features from grayscale SAR images, while the decoder mapped these features to the Lab color space's a and b channels, enabling accurate color reconstruction.

Nishchay Rajput

Gathered and pre-processed SAR images to ensure they were suitable for the colorization model. This involved tasks like normalization, resizing, and data augmentation, which enhanced the dataset and set a solid foundation for effective training and evaluation phases, ultimately improving model performance.

Ojus Goel

Led the training of a deep learning model for mapping SAR images to color. Conducted predictions post-training and processed the outputs by converting them from LAB color space to RGB to produce visually accurate colorized images. Applied denoising techniques to reduce noise inherent in SAR imagery, enhancing the quality of the final outputs.

Patel JanmayGaurav

Responsible for converting image data to Lab color space for colorization, implementing patching to enhance model accuracy by focusing on finer details, and applying denoising techniques to improve image quality.

THANK YOU!

FOR YOUR ATTENTION