SMART INDIA HACKATHON 2024

- **Problem Statement ID - 1733**
- **Problem Statement Title - SAR Image Colorization for Comprehensive Insight using Deep Learning Model**
- **Theme - Space Technology**
- **PS Category- Software**
- **Team ID -**
- **Team Name - VOID**

VOID

SAR Image colorization with U-Net Architecture

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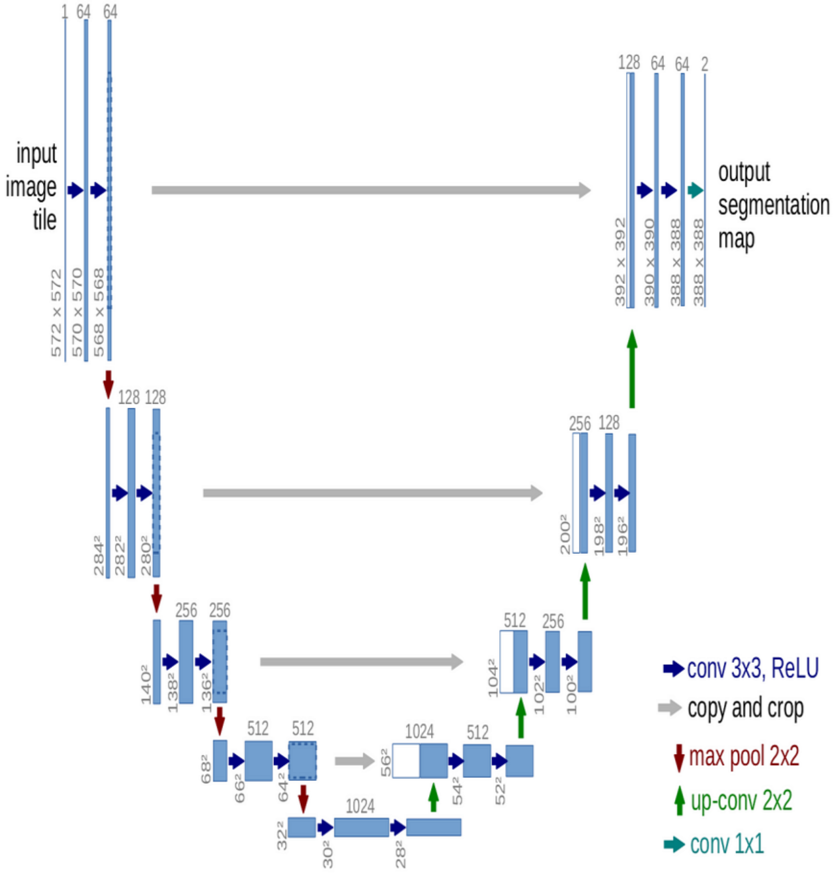
Problem Statement: Develop a deep learning model to accurately colorize grayscale Synthetic Aperture Radar (SAR) images, enhancing feature interpretation and analysis for remote sensing applications.

❖ Solution

- Used U-Net architecture for accurate SAR image colorization.
- Captured fine structural details for accurate color reconstruction, enhancing SAR data interpretability in remote sensing.
- By using a Hybrid model of GAN and U-Net architecture, we can achieve an accuracy of 90-95%.

❖ Advantages

- *__Enhanced Visualisation__*: Clearer, more detailed images for improved feature recognition.
- *__Improved Data Analysis__*: Easier interpretation of large datasets for faster decision-making.
- *__Increased Classification Accuracy__*: Better terrain differentiation for precise classification.
- *__Adaptability__*: Easily applicable to other image translation tasks.



U-Net Architecture

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TECHNICAL APPROACH

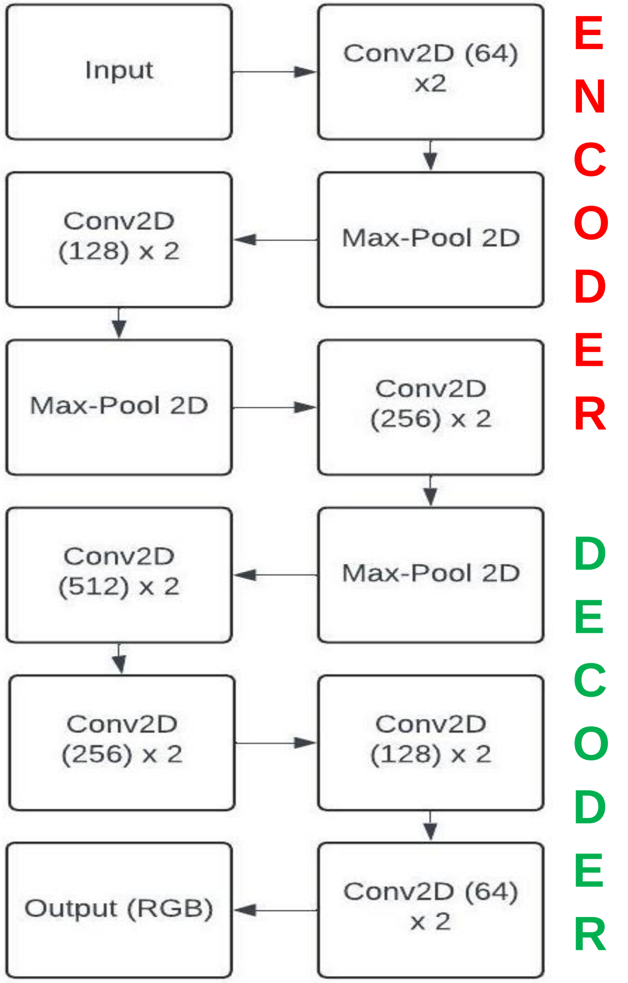
TechStack Used

OpenCV

scikit learn

kaggle

- **Preprocessing**: EuroSAT colour images are converted to grayscale using OpenCV for model input.
- **Data Loading**: Images are resized to (64x64) and normalized.
- **Model Architecture**: U-Net is used for image colorization, with an encoder to extract features and a decoder to reconstruct RGB images.
- **Training**: The model is trained with MSE loss and Adam optimiser on the training dataset.
- **Evaluation**: Performance is validated by comparing grayscale inputs with predicted colorized outputs.



MODEL DESIGN

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FEASIBILITY AND VIABILITY

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➢ Technical Feasibility:

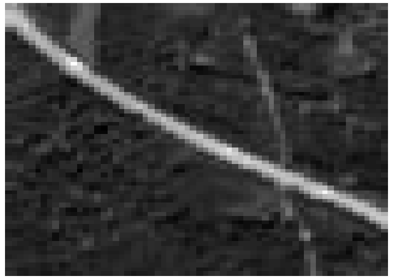
- U-Net’s proven efficiency in image segmentation and colorization tasks makes it highly suitable for SAR image processing.
- Utilises the EuroSAT dataset for diverse and comprehensive training and evaluation.
- Implementable with TensorFlow and OpenCV, ensuring seamless integration with cutting-edge ML and image processing libraries.

➢ **Viability**:

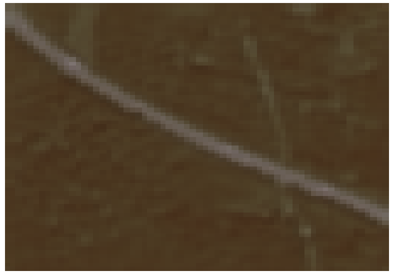
- Enhances interpretability of SAR data for remote sensing applications.
- Scalable solution adaptable to large datasets.
- Potential for integration into real-world systems for environmental monitoring, disaster management, and geological studies.

➢ **Challenges**:

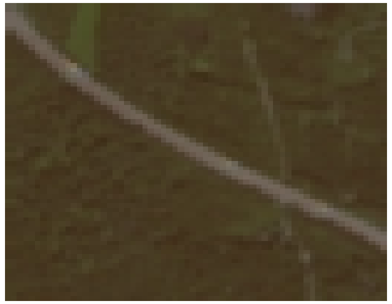
- High computational requirements for training.
- Ensuring accurate colorization in diverse terrains and conditions.



Source Image



Predicted Image



True Image

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IMPACT AND BENEFITS

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➢ Impact:

- Geological Studies: Enhanced mapping and analysis of geological features.
- Environmental Monitoring: Improved detection of environmental changes and resource management.
- Remote Sensing Analysis: Clearer SAR images for more efficient analysis.

➢ Benefits:

- **Social**: Better disaster management and urban planning decisions.
- **Economic**: Reduce cost of analysis and time, boosting efficiency.
- **Environmental**: Supports sustainable resource management with precise data.

➢ Product Status :

- Our U-Net model for SAR image colorization has reached 87-89% accuracy.
- We can improve accuracy upto 90-95% by optimising hyperparameters, using data augmentation, fine-tuning the architecture, and applying transfer learning.

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RESEARCH AND REFERENCES

Key Research:

- U-Net for Image Segmentation: Ronneberger, O., Fischer, P., & Brox, T. (2015). U-Net: Convolutional Networks for Biomedical Image Segmentation.
- SAR Image Processing: Zhang, L., & Xu, Y. (2020). Synthetic Aperture Radar (SAR) Image Processing and Analysis**.**
- F. Muscat and T. Gatt, "Black and White Image Colorization Using Deep Learning Techniques," 2023 International Symposium on Image and Signal Processing and Analysis.
- J. Hwang, "Image Colorization with Deep Convolutional Neural Networks", 2016

Datasets:

- EuroSAT Dataset
- EuroSAT Gray Scale: Custom preprocessing script for converting color images to grayscale.

Tools & Libraries:

- TensorFlow
- OpenCV