TITLE PAGE

- **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 - 7004**
- **Team Name - Ctrl Alt Delete**

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IDEA TITLE

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Overview of Solution

- **Three-Step Framework:** Fusion of SAR and MS images using matching of microwave and optical imagery
- **Region Prediction:** Detecting areas suitable for matching in SAR and optical images.
- **Correspondence Heatmap:** Generating matches using a feature-space cross-correlation.
- **Training the model:** Using generated images to train a CNN for colorizing SAR images.

Problem Addressed

- **Mismatch Challenge:** Overcoming geometric and radiometric differences between SAR and optical imagery.
- **Accurate Alignment:** Ensuring precise matching by predicting suitable regions and refining matches.

Innovation and Uniqueness

- **Deep Learning Application:** Using neural networks to handle complex differences in SAR-optical data.
- **Enhanced Matching Capability:** Improving over traditional methods, enabling joint data use for large-scale scenes.

SAR Image

Colorised Image

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TECHNICAL APPROACH

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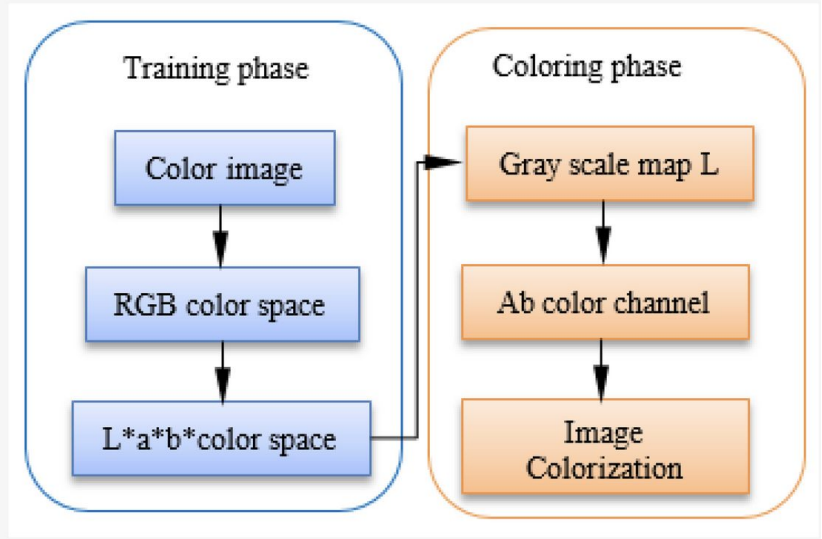
Technologies Used

Python: For deep learning and image processing.
MATLAB: For prototyping algorithms, data visualization, and advanced numerical computations.

Libraries and Frameworks

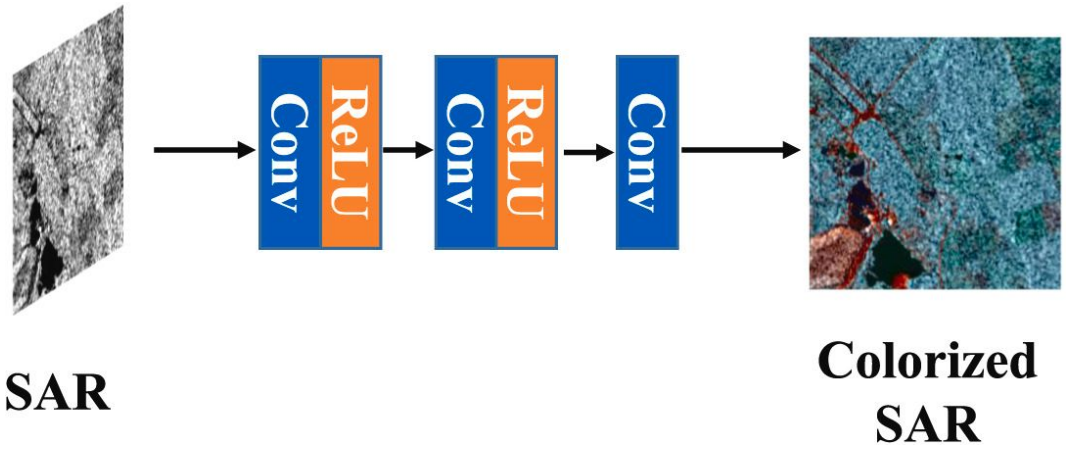
TensorFlow ,OpenCV, scikit-learn, Keras, NumPy/Pandas, Matplotlib/Seaborn, SciPy



Methodology and Process for Implementation

Data Preparation
Collect SAR and optical imagery datasets. Preprocess images (e.g., normalization, resizing) for consistency and optimal network input.

- **Region Prediction Network:** Train to identify suitable regions for matching in both SAR and optical images.
- **Correspondence Heatmap Network:** Train to generate heatmaps using multi-scale feature-space cross-correlation.
- **Outlier Removal Network:** Train to classify and filter out incorrect matches based on the correspondence heatmap.



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FEASIBILITY AND VIABILITY

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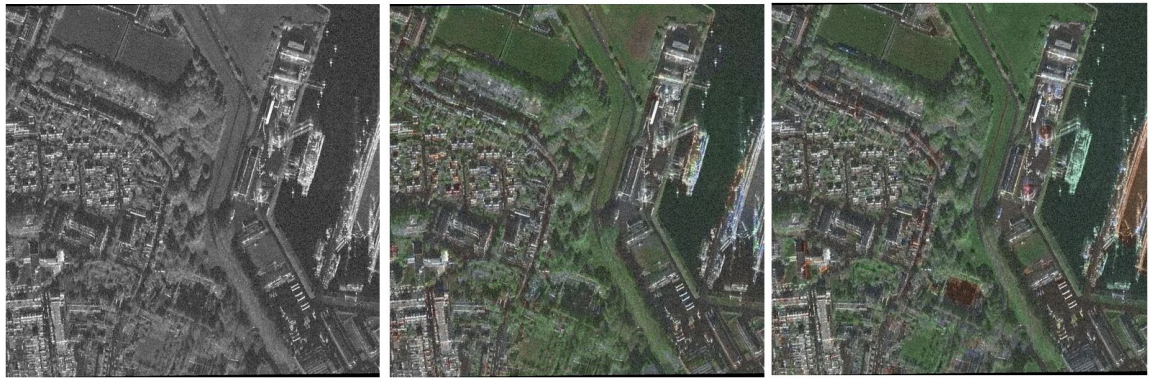
Problems Faced and Risks

- **Data Scarcity:** Limited labeled datasets can restrict the training effectiveness of deep learning models for SAR image colorization.
- **Data Complexity:** SAR images with multiple polarizations and channels add complexity, challenging the integration process for colorization.
- **Computational Costs:** High dimensionality and size of SAR data make model training computationally expensive.
- **Misinterpretation Risks:** Improperly contextualized colorized images can lead to misinterpretation and incorrect conclusions by users.

Solutions

- **Data Augmentation:** Use synthetic data generation to expand the training dataset and improve model generalization.
- **Pre-Trained Models:** Leverage pre-trained datasets to enhance model efficacy and reduce training time.
- **Multi-Modal Fusion:** Integrate additional data sources, like optical images and multi-polarization SAR data, to provide diverse information and improve colorization accuracy.
- **Model Optimization:** Apply pruning to reduce model size, making the process efficient on limited hardware

Input SAR *Colorised Image* *Ground Truth*



Input SAR *Colorised Image* *Ground Truth*

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IMPACT AND BENEFITS

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Environmental

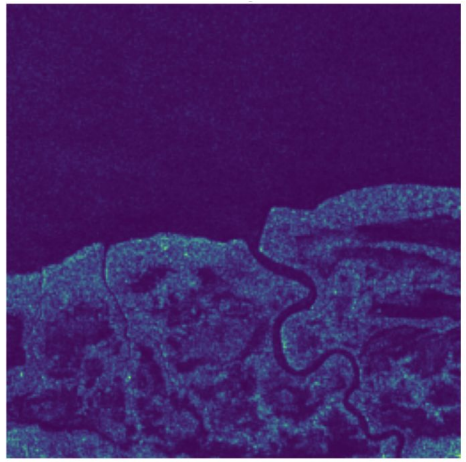
Improved Monitoring of Environmental Changes: Colorized SAR images make it easier to detect environmental changes such as deforestation, soil erosion, and variations in water bodies, enabling conservation efforts.

Effective Disaster Management: By providing clearer images for detecting environmental hazards like oil spills, colorized SAR imagery enhances disaster response capabilities and supports more effective and rapid interventions.

Economic

Resource Efficiency: Colorized SAR images simplify the interpretation process, which can lead to significant savings in time and resources across various sectors.

Enhanced Agricultural Monitoring: Colorized images provide better detail on land cover and crop health, which can improve agricultural planning and resource management, contributing to more productive and cost-effective farming practices.



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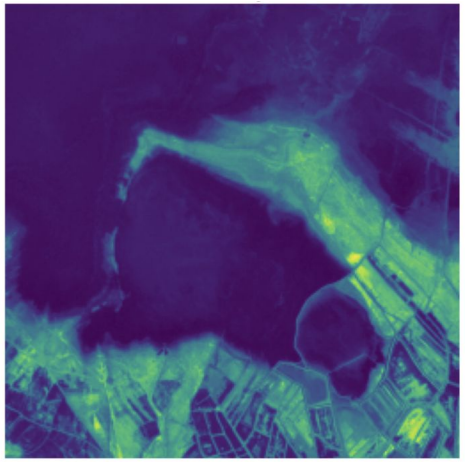

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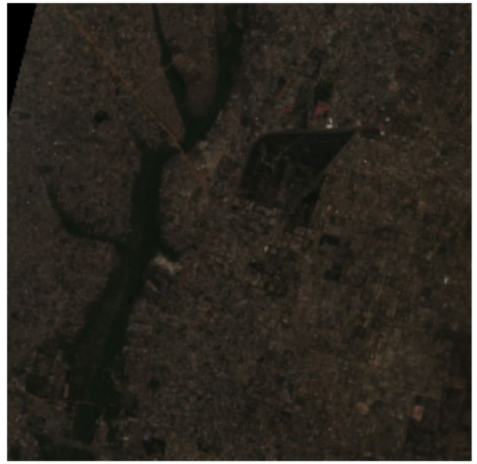

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RESEARCH AND REFERENCES

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References

"Colorizing Synthetic Aperture Radar Images with Deep Learning" by Jian Zhang, et al. IEEE Xplore
“Unsupervised SAR Image Colorization Based on Generative Adversarial Networks" by J. Wang, et al. arXiv
"Fusion of SAR and Optical Images for Enhanced Interpretation" by Peng Liu, et al. ScienceDirect
"Challenges and Solutions in SAR Image Colorization" by Xiangyu Zhang, et al. ResearchGate

Research

NASA (National Aeronautics and Space Administration):
Provides extensive information on satellite missions, Earth observation, and remote sensing technologies, including SAR imaging.

ESA (European Space Agency):
Offers information on ESA’s Earth observation missions and SAR technologies, including data from the Sentinel satellites.

ISRO (Indian Space Research Organisation):
Features information on ISRO's satellite missions, including SAR-based missions like RISAT, and other remote sensing technologies.

ISRO Bhoonidi Software:
Bhoonidhi enables access to ISRO’s archive of Remote Sensing data from 46 satellites, acquired over 33 years