TITLE PAGE

- **Problem Statement ID – SIH1733**
- **Problem Statement Title - SAR Image Colorization for Comprehensive Insight using Deep Learning Model.**
- **Theme - Space Technology**
- **PS Category - Software**
- **Team ID - 4203**
- **Team Name - Apertures**

APERTURES

SAR Image Colorization

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IDEA/ SOLUTION :

- The proposed solution is a Novel **Deep Learning (DL)-based SAR Image Colorization Tool** designed to automatically colorizes **Grayscale Synthetic Aperture Radar (SAR)** images.
- The process includes:

a. **Data Preparation:** Collecting and preprocessing SAR images through Normalization and Data Augmentation.
b. **Model Design : U-NET based Convolutional AutoEncoder Neural Network (Generative AI)** for image colorization, applying transfer learning.
c. **Training:** Training the model with specialized loss functions and high-performance GPUs for efficiency.
d. **User Interface:** A user-friendly web interface with Flask for users to upload SAR images and receive colorized results.

PROBLEM RESOLUTION :

- **Comprehensive Insights:** Colorized SAR images simplify **Feature identification** and change detection.
- **Faster Analysis:** Color outputs make tasks like **detection** and classification **quicker** and easier for **analysis**.
- **Wider Accessibility: Automates colorization**, enabling **non-experts** to **use advanced tools**.

UNIQUE VALUE PREPOSITIONS (UVP) :

- **Advanced Models**: Utilizes **Generative AI (CANN)** based model for precise colorization.
- **Specialized Use**: Targets SAR images specifically.
- **Scalable**: Adapts to varying data and systems.
- **User-Friendly**: Accessible to both experts and novices.
- **High Impact**: Enhances **clarity** for critical applications like **disaster management** and **earth observations**.

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TECHNICAL APPROACH

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❖ TECHNOLOGIES USED

PyTorch TensorFlow Flask

❖ METHODOLOGY

Data collection and preliminary processing

Obtained coupled SAR and optical images.
Normalize, size and resized images.

Sample development

Created a model with **Convolutional AutoEncoder model** architectures.

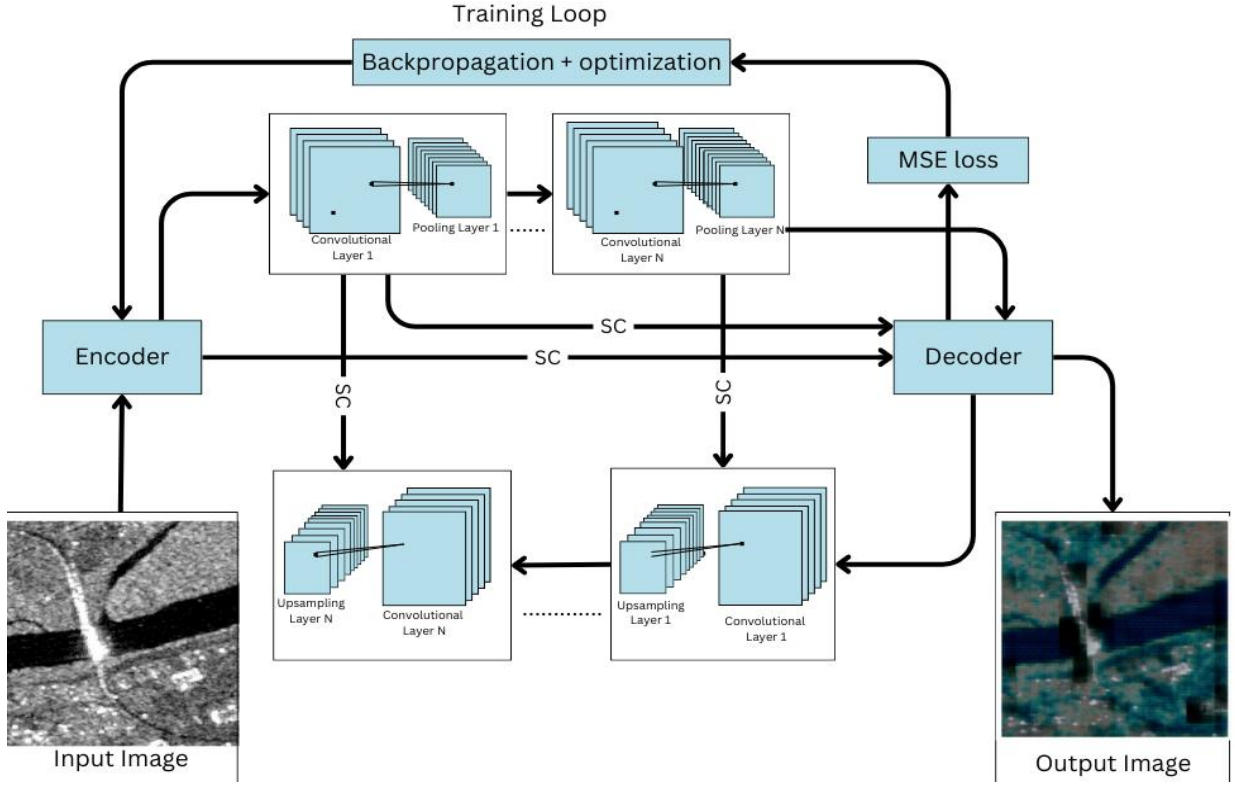
Training Process

Training the model with help of prepared dataset of grayscale and ground-truth images on a high-end GPUs for efficient and optimized results.

Validation and testing

Validating the pre-trained model on unseen data.
Adjusting hyperparameters for optimal results.

PROCESS FLOW ARCHITECTURE



Prototype Link

https://drive.google.com/drive/folders/19EjTMBNXVvr2OQIj7NW489ykVu5SnjP

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FEASIBILITY AND VIABILITY

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❖ FEASIBILITY :

1. **Technical** : SAR data is widely available.
2. **Integration**: Models can be integrated in **existing remote sensing workflows**.
3. **Market**: Strong demand in niche sectors.
4. **Operational**: Advancement in DL allows to train and process models on **moderate computational resources.**
5. **Analytical :** Colorized Images can provide **better insights.**
6. **Innovation :** Contributing advancements in remote sensing and research field**.**

❖ CHALLENGES AND RISKS :

1. **Resources :** High-performance GPUs may be required.
2. **Accuracy :** May **not always** produce **accurate color representations.**
3. **Updation :** Always need to be updated for specific regions.
4. **Performance :** Low pixelated result images.
5. **Storage** : Limited storage due to the size of the SAR images.
6. **Financial** : Using **High-End GPUs** can lead to **increased costs**.
7. **Security** : Ensuring the data **privacy** of **sensible information** contained in SAR images.

❖ STRATEGIES :

1. **Resources** : Usage of **GPU-specific libraries** (CUDA, NCCL, cuDNN).
2. **Accuracy** : **Pre-Trained models** can be implemented to avoid inaccuracies and inefficiency.
3. **Updation** : Region specific pre-trained models can be implemented.
4. **Performance** : Can use **SRGANS** to increase the resolution of the output images.
5. **Storage** : Utilization of **Cloud platforms** to store and **securing** the data (AWS, GCP).
6. **Financial** : Seek for funding.

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IMPACT AND BENEFITS

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❖ IMPACT :

1. **Remote Sensing Analysts:**
   a) **Better Interpretation:** Easier feature identification.
   b) **Faster Analysis:** Quicker decision-making.
2. **Government Agencies and Defense:**
   a) **Improved Monitoring:** Enhanced visualization for key tasks.
   b) **Strategic Edge:** Better data for critical decisions.
3. **Research Institutions:**
   a) **Advanced Studies:** Supports detailed environmental and urban research.
   b) **New Insights:** Reveals hidden patterns.
4. **General Public and Stakeholders:**
   a) **Increased Accessibility:** Makes data easier to understand.
   b) **Greater Awareness:** Highlights satellite data uses in daily life.

❖ BENEFITS :

1. **Social:**
   a) **Easier Communication:** Simplifies SAR image interpretation for **better analytics understanding**.
   b) **Improved Safety:** Faster, more **accurate data** aids in **emergency response.**
2. **Economic:**
   a) **Increased Efficiency:** Saves time and costs for businesses and agencies.
   b) **New Market Opportunities:** Potential for commercialization and system integration.
3. **Environmental:**
   a) **Enhanced Monitoring:** Better **analysis** of environmental changes and **disaster detection**.
   b) **Supports Conservation:** Improves **tracking** of deforestation and resource **management**.

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RESEARCH AND REFERENCES

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❖ REFERENCES :

❑ Research Papers

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8141881
https://shorturl.at/Y9nKR
https://shorturl.at/Ooq0X

- **References**

https://www.kaggle.com/code/dimitrif/domain-knowledge

❑ Datasets

https://www.kaggle.com/datasets/requiemonk/sentinel12-image-pairs-segregated-by-terrain
https://www.kaggle.com/datasets/humansintheloop/semantic-segmentation-of-aerial-imagery
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https://vedas.sac.gov.in/en/sih2024.html