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- **PROBLEM STATEMENT ID** - SIH1732
- **PROBLEM STATEMENT TITLE** - Enhancement of Permanently Shadowed Regions (PSR) of Lunar Craters Captured by OHRC of Chandrayaan-2
- **THEME** - Space Technology
- **PS CATEGORY** - Software
- **TEAM ID** -
- **TEAM NAME** - Lunar Innovators

Lunar Innovators

Low Light Image Enhancement of Lunar Craters

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Proposed Solution

- Use Image Fusion Techniques By Combining Multi-exposure Or Multi-spectral Data From Chandrayaan-2's OHRC To Create A Single High-SNR Image.
- Apply Advanced Filtering Methods To Preserve Details While Reducing Noise, Ensuring A Clearer Interpretation Of Lunar Craters.

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TECHNICAL APPROACH

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Technologies to be Used:

- **Programming Languages:** Python
- **Libraries:** OpenCV, Numpy, scikit-image
- **Tools:** Google Earth Engine for satellite data access, MATLAB for image fusion algorithms
- **Methods:** Multi-Exposure Fusion , Bilateral Filtering, and Wavelet-Based Noise Reduction.

Methodology and Process:

Step 1: Collect and preprocess the lunar images from different exposures or spectral bands.

Step 2: Apply multi-exposure or multi-spectral fusion algorithms to combine the images.

Step 3: Use bilateral filtering to remove noise while preserving edges and important details.

Step 4: Validate using SNR and Structural Similarity Index (SSIM).

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FEASIBILITY AND VIABILITY

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Feasibility:

- Image fusion techniques are widely used in remote sensing and can be applied to OHRC data.
- Image data with varying exposure/spectral bands can be leveraged for better results.

Challenges:

- Lack of multiple exposures or spectral data could limit the fusion approach.
- Combining images without introducing artifacts can be tricky.

Strategies:

- If multiple exposures aren’t available, enhance a single image using other techniques.
- Use adaptive filtering and dynamic range compression to minimize artifacts.

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IMPACT AND BENEFITS

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IMPACT ON TARGET AUDIENCE:

- This technique offers **higher clarity** and **better contrast** for lunar landing site analysis, crucial for future space missions.

BENEFITS:

- **Scientific:** Provides a new method for analyzing lunar poles and PSR regions.
- **Operational:** Enhanced images aid in geomorphological studies and selecting safer landing zones.
- **Technological:** The image fusion method provides improved results compared to single-image enhancement techniques

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RESEARCH AND REFERENCES

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KEY REFERENCES:

- **MULTI-EXPOSURE FUSION TECHNIQUES**
  - Combines multiple exposures to enhance both bright and dark regions for better image clarity.
  - Used in satellite imagery to improve visibility in complex lighting conditions.
  - Techniques like Laplace Pyramid fusion are employed for seamless blending.
- **BILATERAL FILTERING**
  - Reduces noise while preserving edges by averaging nearby pixels based on distance and intensity.
  - Effective in satellite and radar imagery, maintaining critical features.
  - Used to enhance image quality without blurring important detail

Links:

- Chandrayaan2 Complete Project Payloads (isro.gov.in)
- Sentinel Hub (sentinel-hub.com)
- Advancements in low light image enhancement techniques and recent applications - ScienceDirect