SMART INDIA HACKATHON 2024

TITLE PAGE

- **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-** Shadow Explorers

Shadow Explorers

Lunar PSR Enhancement

SMART INDIA HACKATHON 2024

Addressing the Problem

- **Goal:** Enhance image quality to gain a deeper understanding of PSRs, aiding future lunar exploration missions.
- **Method:** Use advanced image processing and machine learning techniques to tackle the challenging lighting conditions found in these regions.
- **Key Challenge:** Transform the faint light signals from PSR regions into clear, high-quality images with strong Signal-to-Noise Ratios (SNR).
- **Unique Approach:** Develop a specialized solution tailored to Chandrayaan-2's data, rather than relying on general-purpose image enhancement methods.
- **Focus Areas:** Improve image clarity and reduce noise while leveraging the rich lunar topography insights from this unique dataset.

Proposed Solution

- **Lunar-Specific:** Optimized for low-light data from PSR regions, surpassing general solutions.
- **AI-Powered:** Deep learning enhance noise reduction while retaining key details.
- **Image Pre-processing:** The system loads grayscale images and divides them into smaller tiles for efficient processing.
- **Image Enhancement:** AI-driven techniques improve contrast, adjust brightness, and reduce noise for better image quality.
- **Tile Blending:** Merging algorithms ensure a seamless final image by blending enhanced tiles smoothly.
- **User Interface:** Users upload images through a web or app interface, and the system returns enhanced images with minimal effort.

Shadow Explorers

TECHNICAL APPROACH

SMART INDIA HACKATHON 2024

Methodology and Process for Implementation

a. AI Pre-processing
- Load Image: Grayscale image loaded using OpenCV.
- Image Tiling: Image split into tiles for efficient **ML processing**.

b. ML-Based Enhancement
- CLAHE: OpenCV enhances contrast.
- Gamma Correction: **Deep learning** in TensorFlow adjusts brightness.
- Adaptive Filtering: **AI** reduces noise via adaptive filters.

c. Tile Blending
- **ML** merges tiles seamlessly.

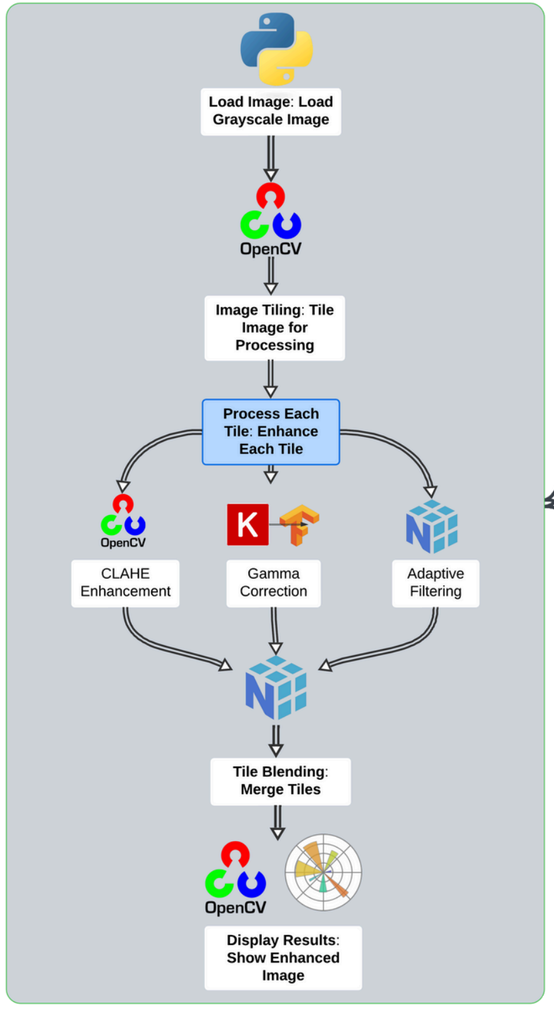
d. AI Metrics
- AI measures MAE, MSE, PSNR, and SNR.

e. Web/App Interface
- Users upload, and deep learning enhances images.

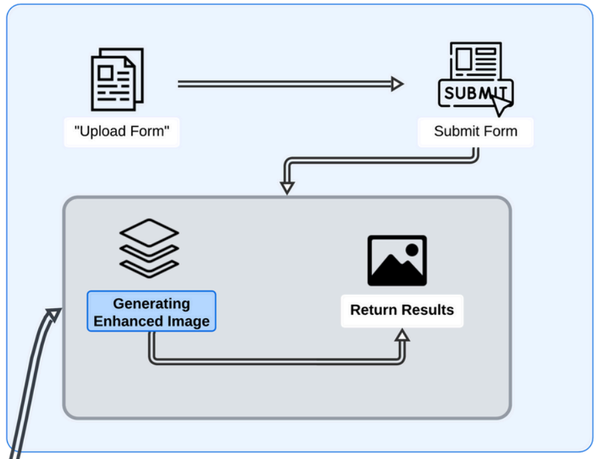
Technologies

Python Open CV Numpy Keras Matplot Tenser Flow HTML CSS Java script Flask

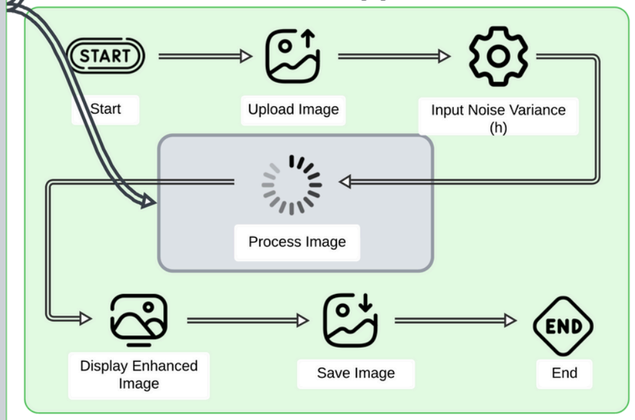
Flowchart



Deep Learning Algorithm



Web - Based Approach



App - Based Approach

Shadow Explorers

FEASIBILITY AND VIABILITY

SMART INDIA HACKATHON 2024

Feasibility:

- Sufficient high-resolution information from OHRC
- Supported by the existing High Performance Computing infrastructure
- Multiple enhancement techniques implemented (CLAHE, gamma correction)
- ML/DL techniques suitable for noise reduction and low-light enhancement (CNNs).

Viability:

- Adaptable framework for AI/ML technique integration with deep learning
- Possibly achievable within 1-2 years for development and deployment.
- Existing solutions can be quickly adapted.
- Such information forms the key aspects in the selection of site landing and geomorphological analysis.

Next Steps:

- Implement models for effective noise reduction in PSR images.
- Develop lunar-specific custom loss functions for PSR images.
- Apply techniques to enhance limited PSR datasets, improving model robustness.
- Focus on computational efficiency for real-time processing capabilities..

Challenges:

- Fine-tuning deep learning models for PSR-specific image characteristics.
- Achieving a balance between preserving image details and reducing noise.
- Validating enhanced images with limited ground truth data from lunar missions.

Shadow Explorers

IMPACT AND BENEFITS

SMART INDIA HACKATHON 2024

Impacts

- **Landing site selection:-** Enhanced images will provide clearer details of the terrains and hazards in PSR regions, helping mission planners choose safer future lunar missions.
- **Geomorphological Application:-** Better image quality will allow scientists to study the lunar surface in depth by enabling a deeper understanding of the Moon's geological history especially in the hardest regions of PSR.
- **Boosting Global Cooperation:-** Helps bring together space agencies and research institutions worldwide by providing high-quality data and innovative tools, fostering teamwork and shared efforts in exploring the Moon.

Benefits

- **Social Benefit:** The software can boost public interest in space science, inspiring students and researchers to pursue scientific careers and fostering a culture of innovation.
- **Economic Benefit:** Improved imaging reduces mission risks and costs due to reduction in fail attempts.
- **Resource Identification**: PSRs are thought to contain valuable resources, like water ice. Better imaging can help locate and quantify these resources, which are vital for sustaining long-term human presence on the Moon.

Shadow Explorers

RESEARCH AND REFERENCES

SMART INDIA HACKATHON 2024

Details / Links of the reference and research work

ABOUT CHANDRAYAAN 2 :- CLICK HERE

-ISRO

ANALYSIS OF PSR :- CLICK HERE

-ScienceDirect

PEERING INTO PSR :- CLICK HERE

-Nature

ABOUT CHANDRAYAAN IN BRIEF :- CLICK HERE

-ISRO

ABOUT LAUCHER, LANDER, ROVER :- CLICK HERE

-ISRO