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ENHANCEMENT OF PSR LUNAR CRATERS CAPTURED BY OHRC CHANDRAYAAN-2

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ABSTRACT- ***Permanently Shadowed Regions (PSRs) located near the lunar poles are among the most scientifically significant areas on the Moon due to their potential to contain water ice deposits and other volatile materials. However, these regions receive little or no direct sunlight, making image interpretation and analysis extremely challenging. This work presents an image enhancement framework for PSR lunar crater images captured by the Orbiter High Resolution Camera (OHRC) onboard Chandrayaan-2. The proposed methodology employs preprocessing techniques such as noise reduction, contrast enhancement, histogram equalization, Contrast Limited Adaptive Histogram Equalization (CLAHE), and gamma correction to improve the visibility of shadowed regions. The enhanced images reveal hidden surface features and geological structures that are difficult to observe in the original images. Performance evaluation is carried out using image quality metrics such as Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index Measure (SSIM). Experimental results demonstrate significant improvements in visual quality and feature visibility, supporting future lunar exploration and scientific investigations.***

KEYWORDS: Chandrayaan-2, OHRC, Lunar Craters, Permanently Shadowed Regions, PSR Enhancement, Image Processing, CLAHE, Histogram Equalization.

INTRODUCTION

The Moon's polar regions contain several craters whose interiors remain permanently shadowed due to the low angle of sunlight. These areas, known as Permanently Shadowed Regions (PSRs), are of great scientific interest because they may preserve water ice and volatile compounds for billions of years. The Chandrayaan-2 mission launched by ISRO carries the Orbiter High Resolution Camera (OHRC), which captures detailed images of the lunar surface including polar craters.

Due to extremely low illumination conditions, PSR images often suffer from poor contrast and limited visibility. This makes geological analysis, crater mapping, and resource identification difficult. Therefore, effective image enhancement techniques are required to reveal hidden information within shadowed lunar regions.

LITERATURE SURVEY

Several researchers have investigated image enhancement techniques for low-light and planetary imaging applications. Histogram Equalization has been widely used to improve image contrast in dark environments. Adaptive Histogram Equalization and CLAHE have demonstrated superior performance in enhancing local image details while preventing excessive noise amplification.

NASA and ISRO researchers have used various enhancement approaches for lunar imagery analysis. Recent studies have explored machine learning and deep learning techniques for restoring poorly illuminated images.

RELATED WORK

Several researchers and space agencies have conducted extensive studies on lunar polar regions and image enhancement techniques to improve the visibility of Permanently Shadowed Regions (PSRs). These studies have contributed significantly to understanding lunar surface characteristics and the presence of water ice deposits in shadowed craters.

EXISTING SYSTEM

The existing system for analyzing Permanently Shadowed Regions (PSRs) of lunar craters primarily relies on raw images acquired from lunar missions such as Chandrayaan-2 and the Lunar Reconnaissance Orbiter (LRO). These images are directly used for visual interpretation and scientific analysis with minimal image enhancement. Since PSRs receive little or no direct sunlight, the

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captured images often contain extremely dark regions, low contrast, and poor visibility of surface features. As a result, researchers face significant challenges in identifying crater boundaries, geological structures, and potential water ice deposits. Traditional image processing methods used in existing systems mainly focus on basic brightness and contrast adjustments.

PROPOSED SYSTEM

The proposed system focuses on enhancing Permanently Shadowed Region (PSR) images of lunar craters captured by the Orbiter High Resolution Camera (OHRC) onboard Chandrayaan-2. The objective of the system is to improve the visibility of dark and poorly illuminated lunar regions using advanced image processing techniques. By enhancing image quality, the system enables better identification of crater boundaries, geological formations, and potential water ice deposits hidden within permanently shadowed areas. The final enhanced images provide clearer visualization of lunar surface features, supporting scientific investigations and future lunar exploration missions.

SYSTEM ARCHITECTURE

The system architecture of the proposed PSR enhancement framework consists of multiple stages that process lunar crater images captured by the Orbiter High Resolution Camera (OHRC) of Chandrayaan-2. The architecture is designed to improve the visibility of Permanently Shadowed Regions through image enhancement techniques and quality evaluation metrics.

The preprocessed images are then subjected to Histogram Equalization to improve global contrast. Subsequently, Contrast Limited Adaptive Histogram Equalization (CLAHE) is applied to enhance local image details and reveal hidden surface features within shadowed regions.

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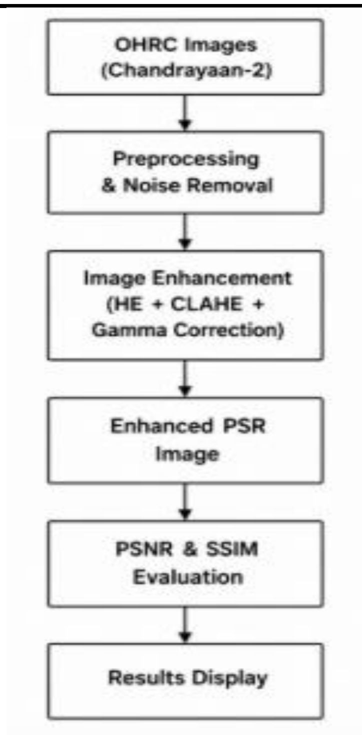

Fig 1: System Architecture

METHODLOGY DESCRIPTION

The methodology is designed to enhance Permanently Shadowed Region (PSR) images captured by the Orbiter High Resolution Camera (OHRC) onboard Chandrayaan-2. Since PSR images suffer from extremely low illumination and poor visibility, a sequence of image processing techniques is applied to improve image quality and reveal hidden lunar surface features.

RESULTS AND DISCUSSION

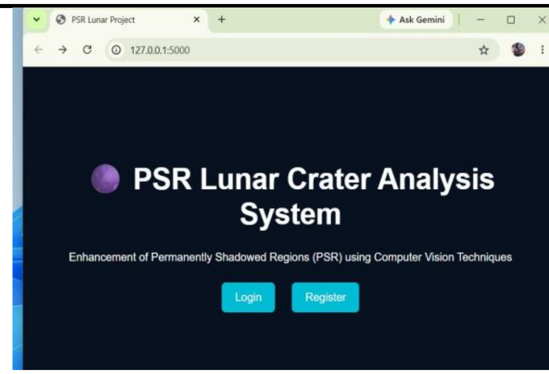

Fig2: Home page

The Home Page serves as the main entry point of the **PSR Lunar Crater Analysis System**. It provides users with an intuitive interface to access the system functionalities related to the enhancement and analysis of Permanently Shadowed Regions (PSRs) captured by the OHRC camera of Chandrayaan-2.

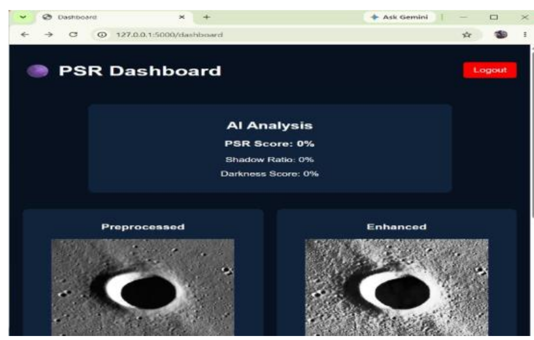

Fig 3: About Module

The PSR Lunar Crater Analysis System provides detailed information about the project's purpose, objectives, and functionalities. This module helps users understand how the system enhances Permanently Shadowed Region (PSR)

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images captured by the Orbiter High Resolution Camera (OHRC) onboard Chandrayaan-2.

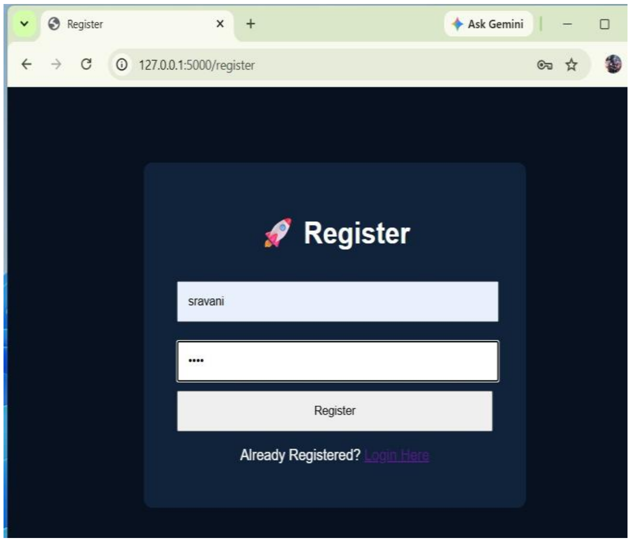

Fig 4: Register Page

The Module is an essential component of the PSR Lunar Crater Analysis System that allows new users to create an account and gain access to the application's features. This module provides a secure registration process where users can enter their username and password to create login credentials. The registration information is stored in the database and is later used for user authentication.

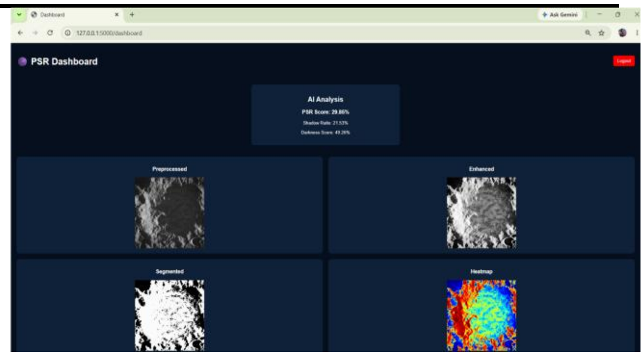

Fig 5: Image Enhancement

The **Image Enhancement Module** is one of the core components of the PSR Lunar Crater Analysis System. This module is responsible for improving the visibility and quality of Permanently Shadowed Region (PSR) images captured by the OHRC camera onboard Chandrayaan-2. Since PSR images contain dark regions with limited illumination, image enhancement techniques are applied to reveal hidden lunar surface features and improve visual interpretation.

CONCLUSION

The Enhancement of Permanently Shadowed Regions (PSR) of Lunar Craters Captured by OHRC of Chandrayaan-2 using advanced image processing and computer vision techniques. Due to the extremely low illumination conditions within lunar polar craters, the original OHRC images often

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contain poor contrast and limited visibility of surface features.

FUTURE SCOPE

The proposed PSR Lunar Crater Analysis System can be further enhanced by incorporating advanced Artificial Intelligence, Machine Learning, and Deep Learning techniques to improve the accuracy and efficiency of lunar image analysis. Future developments may focus on automatically detecting and classifying Permanently Shadowed Regions, identifying potential water ice deposits, and extracting geological features from OHRC images with minimal human intervention.

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