Team Name: Pyaj

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IMAGE BASED SEARCH OF LUNAR CRATERS FROM GLOBAL MOSAIC

Our project focuses on precisely locating lunar craters using Chandrayaan-2 TMC images and the LRO WAC global mosaic. We will develop software to manage spatial resolution differences, perform template matching, and efficiently store and search the lunar mosaic. The approach involves aligning high-resolution Chandrayaan-2 TMC images (5m) with the 100m LRO WAC mosaic by applying a downscaling algorithm with interpolation techniques. For crater identification, we will use OpenCV for template matching, incorporating pre-processing methods like histogram equalization and multi-scale matching to handle size variations, ensuring a correlation score of ≥ 0.70. To support efficient data storage and retrieval, we will use spatial databases like PostGIS, implementing indexing for quick access. The software will integrate QGIS for visualization and OpenCV for processing, featuring a user-friendly interface for uploading crater images and displaying results. Expected outcomes include accurate latitude and longitude coordinates for craters and effective visualization on a lunar map. The solution aims to achieve high precision in crater location and provide a robust tool for lunar research by meeting performance metrics and ensuring a correlation value of ≥ 0.70 for template matching.

Tools and Technology Used

- **QGIS**: For geospatial data visualization and analysis.
- **OpenCV**: For image processing and template matching.
- **Python**: Primary programming language for software development.
- **PostGIS**: For efficient storage and retrieval of spatial data.
- **USGS Data Portal**: Source for LRO WAC global mosaic.
- **ISSDC**: Source for Chandrayaan-2 TMC images.

Differentiation from Other Solutions

Our solution stands out by effectively addressing the challenge of varying spatial resolutions between Chandrayaan-2 TMC and LRO WAC images. Unlike other approaches, we implement advanced downscaling algorithms to align high-resolution TMC images with the WAC mosaic, ensuring accurate template matching. Additionally, our integration of QGIS and PostGIS provides robust tools for geospatial data management and visualization, enhancing user experience and efficiency.

Problem Solving

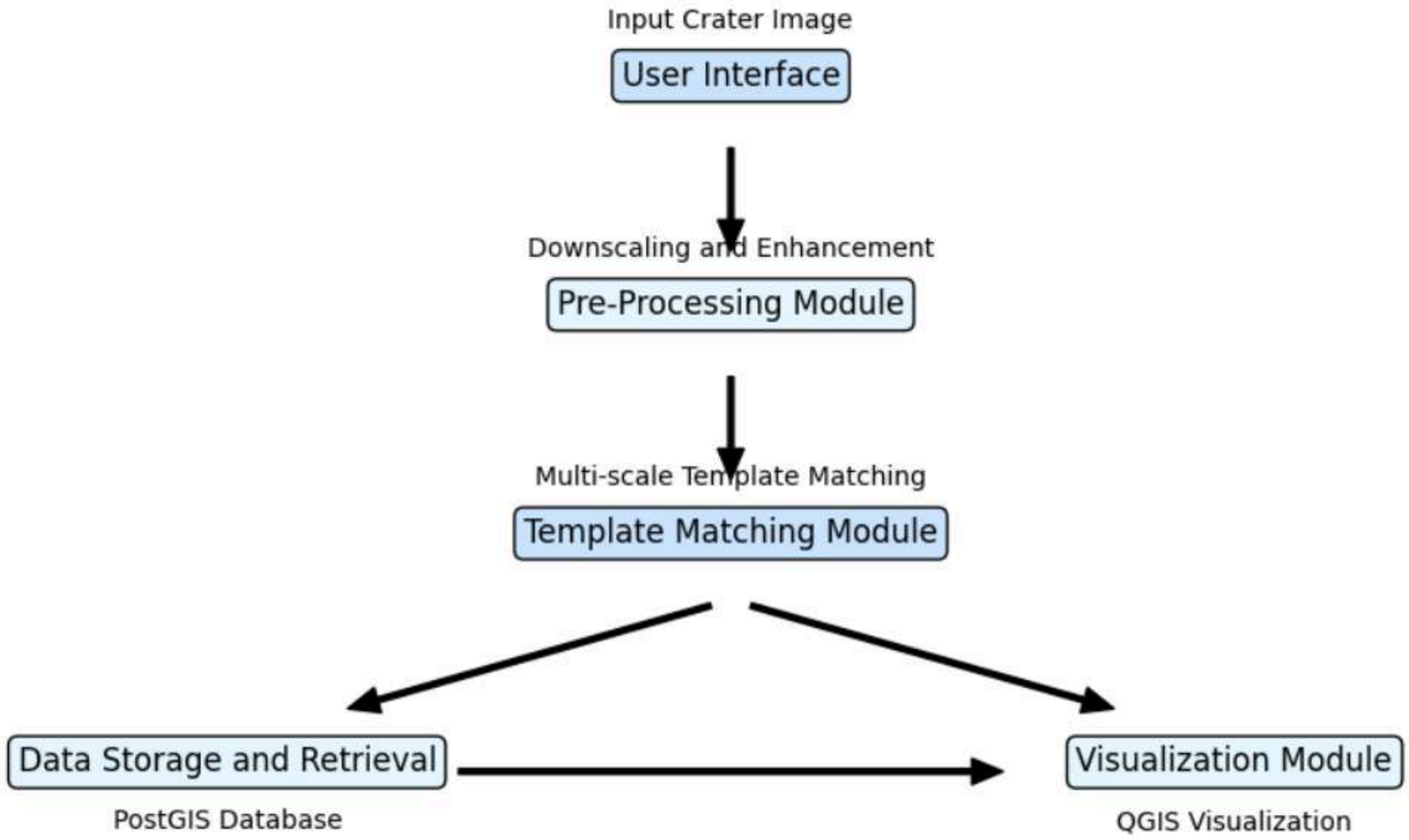
The key challenge is accurately locating craters in the WAC mosaic using higher-resolution TMC images. Our solution tackles this by:

1. Resolution Alignment: Downscaling TMC images to match the WAC mosaic's 100m resolution, ensuring consistency in the template matching process.
2. Template Matching: Utilizing OpenCV for multi-scale template matching, allowing us to detect craters of varying sizes. Pre-processing techniques, such as histogram equalization, improve match accuracy.
3. Efficient Data Handling: Implementing PostGIS for efficient storage and retrieval of the WAC mosaic, enabling quick searches and seamless integration with our software.

Unique Selling Proposition (USP)

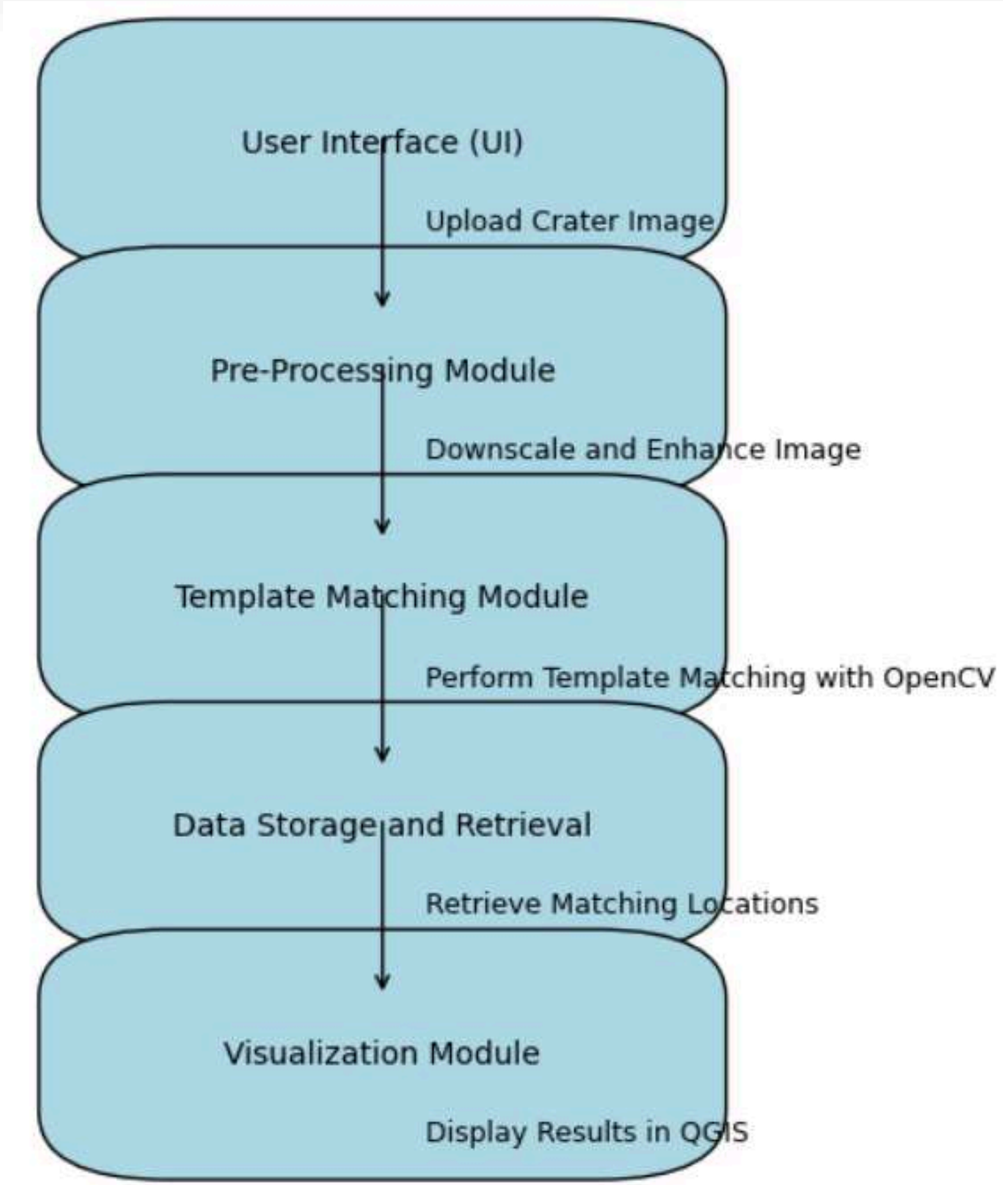
Our solution's USP lies in its comprehensive and integrated approach:

- Accuracy: By addressing spatial resolution differences and employing advanced template matching techniques, we achieve high precision in crater location.
- Efficiency: The use of spatial databases ensures rapid data access and management, significantly reducing processing time.
- User-Friendly Interface: Integration with QGIS provides an intuitive interface for visualization, making the software accessible to users with varying levels of technical expertise.

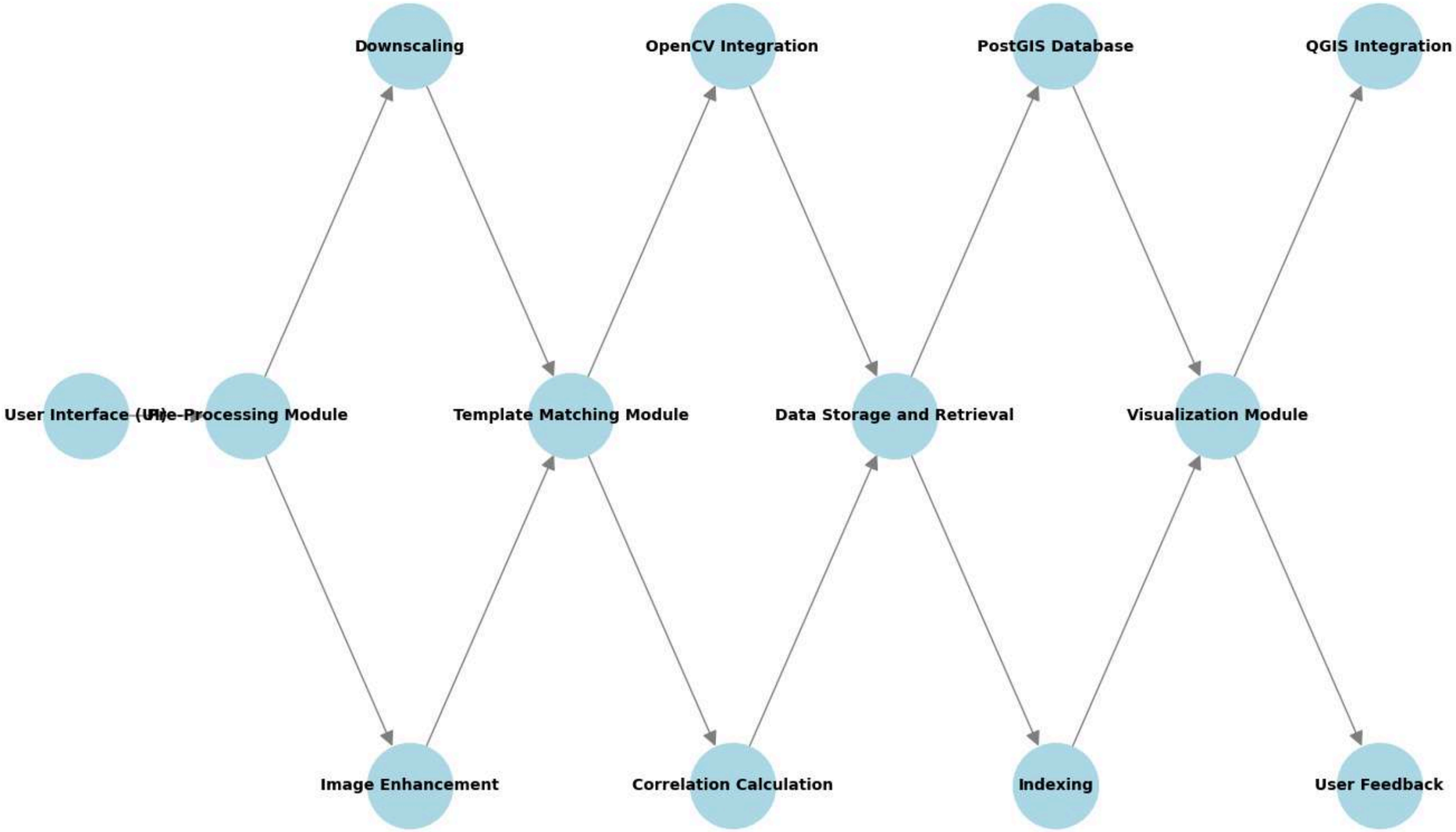

Input Crater Image
User Interface
Downscaling and Enhancement
Pre-Processing Module
Multi-scale Template Matching
Template Matching Module
Data Storage and Retrieval
PostGIS Database
Visualization Module
QGIS Visualization

List of Features Offered by the Solution

1. High-Resolution Crater Identification
   - Accurate identification of craters using Chandrayaan-2 TMC images and LRO WAC mosaic.
   - Advanced downscaling techniques to align image resolutions.
2. Template Matching
   - Multi-scale template matching using OpenCV.
   - Ensures high correlation values (≥ 0.70) for accurate crater detection.
3. Efficient Data Storage and Retrieval
   - Utilization of PostGIS for storing and managing large geospatial datasets.
   - Rapid querying and indexing for quick data access.
4. Interactive Visualization
   - Integration with QGIS for intuitive visualization of crater locations.
   - Detailed display of latitude and longitude on the lunar map.
5. User-Friendly Interface
   - Simple and intuitive interface for uploading crater images and viewing results.
   - Accessible to users with varying levels of technical expertise.
6. Scalability
   - Designed to handle a large volume of image data and extensive lunar surface areas.
   - Efficient processing and storage capabilities ensure scalability.
7. Accuracy and Validation
   - High precision in locating craters with validation through correlation scores.
   - Ensures reliable and accurate results for scientific and research purposes.
8. Seamless Integration
   - Compatible with various data sources (USGS for LRO WAC, ISSDC for TMC images).
   - Smooth integration of multiple software tools (OpenCV, QGIS, PostGIS).
9. Comprehensive Data Management
   - Robust data management system for handling geospatial data efficiently.
   - Supports data import, storage, processing, and visualization.
10. Support and Documentation
    - Comprehensive user guides and documentation.
    - Support for troubleshooting and user queries.


User Interface (UI)
Upload Crater Image
Pre-Processing Module
Downscale and Enhance Image
Template Matching Module
Perform Template Matching with OpenCV
Data Storage and Retrieval
Retrieve Matching Locations
Visualization Module
Display Results in QGIS

Proposed Solution Architecture



Our solution leverages advanced image processing and geospatial tools to accurately locate lunar craters using data from Chandrayaan-2 TMC and the LRO WAC global mosaic. The process begins with users uploading high-resolution crater images from Chandrayaan-2 TMC. These images are then downscaled and enhanced to match the 100m resolution of the LRO WAC mosaic. Utilizing OpenCV, our software performs multi-scale template matching to identify and locate craters within the mosaic. The matching process is validated by ensuring a correlation value of ≥ 0.70. Data management is streamlined through PostGIS, which stores and retrieves the WAC mosaic efficiently. For visualization, the solution integrates with QGIS, allowing users to view and interact with crater locations on a lunar map. This approach not only addresses the challenges of resolution differences but also provides a comprehensive and user-friendly interface for precise crater identification. By combining these advanced technologies, our solution ensures high accuracy, rapid processing, and effective data management, making it a robust tool for lunar research and exploration.

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Innovation partner H2S HACK2SKILL

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THANK YOU