

# Lunar Surface Images Enhancement for Space Resources Localization and Extraction

Jose I. Delgado-Centeno, Pedro J. Sánchez-Cuevas,  
Carol Martinez, Miguel A. Olivares-Mendez  
SnT, University of Luxembourg

## Project description

Lunar surface images are, in some cases, limited regarding the resolution and the quality that they present. This is caused by both the limitations of the instrumentation onboard the satellite that is taking the captures and the environmental conditions of the moment when the image was obtained. A proposed solution based on deep learning and image super resolution called *Lunar HighRes-net* has been developed by SpaceR, the space robotics research group of the University of Luxembourg. It presents an alternative to the launch of new and costly space missions to obtain lunar surface images with improved resolution.

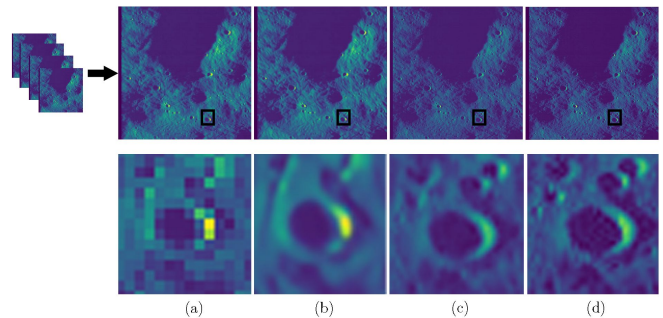


Fig 1. Super resolution methods applied to NASA's LRO lunar surface images. (a) Bicubic interpolation, (b) ESDR, (c) Lunar HighRes-net (proposed work) and (d) Ground truth. The images are presented in color map to better so the details of every result can be perceived better.

## Lunar HighRes-net

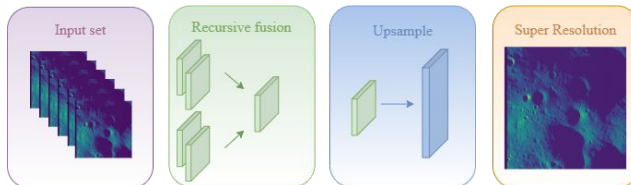


Fig 2. Lunar HighRes-net network architecture. Recursive fusion layers followed by upsampling generates a single super resolution image of the lunar surface area covered by the multiple satellite frames that are used as input.

*Lunar HighRes-net* is a convolutional neural network specialized in quality enhancement of lunar surface images:

- **Input:** Multiple satellite images of a single lunar region.
- **Network:** Image fusion and upsampling.
- **Output:** Single image super resolution of the lunar surface.

## Lunar resources and image super resolution

This approach opens a good opportunity for space resources as it benefits future research in the field:

- **Localization:** Super resolution deep learning architectures can be employed to enhance multispectral images, commonly used for resource reserve localization.
- **Extraction:** Enhanced maps would allow to increase the autonomy of the rovers navigating the lunar surface, achieving more accuracy and reducing time consumption in the tasks performed.

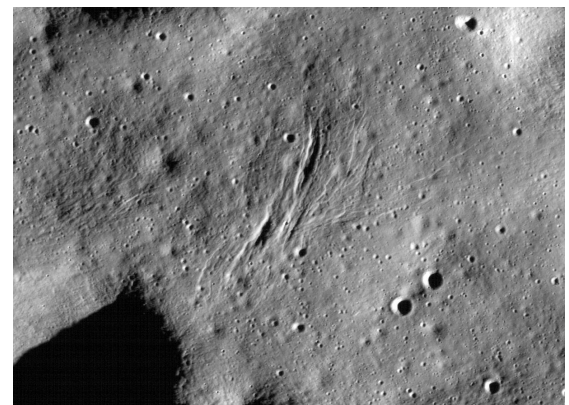


Fig 3. Lunar surface image from NASA's remote sensing mission Lunar Reconnaissance Orbiter