Enhancing Martian Orbital Imagery
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1. Introduction
Exploration of various celestial bodies has always relied upon remote sensing to obtain information over large areas. Space-born sensors are best suited for this task, but generally have coarser spatial resolution compared to drone or field imagery. In recent years, the field of Single Image Super-Resolution (SISR) received attention for its ability to use machine learning to train a model that can effectively enhance the spatial resolution of remote sensing images from a single low-resolution image [1].

2. Objectives
Train two super-resolution highly specialized models [2] to enhance the spatial resolution of HIRISE imagery using imagery from analog terrains provided by Mission Control Space Services.

- Train a model to pass from orbital to aerial resolution (25cm - 3.2cm) using the Real-ESRGAN [3] model.
- Train a model to pass from aerial to ground resolution (3.2cm - 5mm) using the Real-ESRGAN [3] model.

3. Study Site
Iceland
- Situated in semi-dried glacier deltas
- Total of five images covering 0.4 Km²
- Images acquired in 2019 and 2021

4. Methods

5. Results

<table>
<thead>
<tr>
<th>High resolution image</th>
<th>Degraded Image (Bicubic)</th>
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</thead>
<tbody>
<tr>
<td>Real-ESRGAN 4x</td>
<td>26.3 db</td>
</tr>
<tr>
<td>Real-ESRGAN 8x (ours)</td>
<td>25.31 db</td>
</tr>
<tr>
<td>SSIM</td>
<td>0.54</td>
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<td></td>
<td>0.42</td>
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6. Discussion
- The training of the first model (8x) did not give the results anticipated on HIRISE imagery. Our opinion is that the training dataset was not diverse enough and did not sufficiently represent the Martian conditions.
- The training of the second model has been delayed since there was not a sufficient amount of data to train the model.
- The initial idea that training highly specialized models would result in more precise estimations from the model was not proven.

7. Conclusion
- Super-resolution is a proven technique, the unsatisfactory results obtained in this project could be explained by the lack of diversity in the training data and the architecture choice.
- Training a model with an architecture more specific to remote sensing would possibly be beneficial compared to the generic Real-ESRGAN.
- It is important to understand that the images generated are predictions based on training meaning that scientific conclusions must be careful.

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