**Introduction:** Exploration of various celestial bodies has always heavily relied upon remote sensing to obtain information over large areas. Space-borne sensors are best suited for this task but generally have coarser spatial resolution compared to drone or field imagery. For example, the highest orbital spatial resolutions currently available for Mars comes from the High-Resolution Imaging Science Experiment (HiRISE) which has a resolution of 25 cm per pixel.

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]. The Enhanced Super-Resolution Generative Adversarial Network (ESRGAN) model, a specific type of leaning based SISR, has been widely used on a variety of contexts from daily life images to remote sensing imagery [e.g., 2]. Its most recent iteration, the Real-ESRGAN model [3], represent a significant improvement by adding a focus on simulating real-world degradation of images during training. In this study, we explore the use of the Real-ESRGAN model to evaluate its potential to enhance remote sensing imagery at two ranges of spatial scales: from orbital to drone resolution, and from drone to rover resolution.

**Methods:** We will train two highly specialized networks based on sensors present on current Martian missions: HiRISE, the Return-To-Earth (RTE) color camera onboard Ingenuity and Perseverance’s NavCam. In order to simulate the sensors onboard the aforementioned platforms, we used data from a field campaign conducted in Iceland provided by a partnership with Mission Control Space Services Inc. The first model aims at transitioning from orbital resolution to drone resolution simulating the HiRISE camera and the RTE camera. In optimal conditions, these sensors provide a spatial resolution of 25 cm and 3.2 cm respectively. These resolutions require a model with a scale factor of approximately 8x to go from one resolution to the other. The second model specializes in going from drone to rover spatial resolution. This model simulates the transition from the RTE camera and Perseverance’s NavCam with average spatial resolutions of 3.2 cm and 5 mm respectively. That transition requires a model with a scale factor of approximately 6x. This study aims at integrating both models so that the output of the first one is the input of the second. Such integration results in a scale factor of 48x, which is vastly superior to the 2x, 4x and 8x scale factors generally seen in the literature [1-3]. A significant focus on evaluating the pertinence and limitations of such a big scale factor is therefore allocated to the project.

**Preliminary results:** Although the project is still in its preliminary phase, early results obtained by fine-tuning an existing model made available by Wang et al. [3] shows potential. Since the data from the field campaign was not yet available, this finetuning was made using tiles extracted from HiRISE images near Jezero Crater. These tiles were degraded to a spatial resolution of 1 meter which represents a scale factor of 4x. The results show a significant visual improvement between the degraded and re-upscaled images, yet there is room for improvement when compared to the original images.

**Conclusion and future work:** Potential benefits of this project to mission planning and landing site selection are considerable. Companies and space agencies would be able to obtain superior spatial resolution from existing imagery and sensors, therefore achieving greater situational awareness without increasing cost.

As mentioned, only the Real-ESRGAN model is currently being tested. Future work will include a comparison of results obtained with other models to find those who are better suited for the task.

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