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Super-Resolution Test of Huygens Descent Titan Images

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Abstract

The best resolution existing images of the surface of Titan were acquired on 14 January 2005 by the Huygens landing probe. A synthetic increase of resolution is shown here which is based on multiple-sampled scenes and a super-resolution algorithm.

1. Super-Resolution

The term "super-resolution" comprises a set of techniques designed to synthetically increase the resolution of images of a scene.

Super-resolution methods are usually divided into two groups: time-invariant and time varying.

The first group includes methods for increasing the resolution of a single image. In general, they can be considered interpolation methods and thus the final image has the same amount of information as the initial image. All commercial image processing packages include interpolation methods, from simple (nearest neighbor, linear, bicubic) to more complex and efficient (splines, wavelets). Among these, there is the Lanczos transform that, among other advantages, eliminates the artifacts produced by compression algorithms [1].

In the second group are methods that, using information from several images of the same scene, taken at different times, produce an image that contains more information than any of the original ones. Of the various methods available, the algorithm of Irani and Peleg [2] stands out.

This algorithm is a back-propagation of errors and, as usual, requires careful pre-processing of data which here includes a normalization of the histograms of the original images and their subsequent alignment.

The Irani and Peleg algorithm starts by creating a hypothetical picture of output, T_0, and based on information gathered during the alignment process (differences between the images), creates a set of simulated input images. Then, the error per pixel between the original and simulated images is computed, back-propagated and subtracted from T0 giving rise to a new hypothesis, T_1. This process is iterated n times to achieve an image T_n whose error is arbitrarily minimum.

2. Application to Huygens images

The full set of Huygens descent raw images is available at [3].

These images are stored as triplets corresponding to the three samplings made by the Descent Imager / Spectral Radiometer (DISR) onboard the probe: lower-resolution horizontal, mid-resolution at 45° and higher-resolution nadir [4].

We chose the now well known scene of a small drainage basin, sampled on triplets 541a and 553a (Figures 1 and 2).

Figure 3 shows the first super-resolution test which was based on the images on Figures 1 and 2.

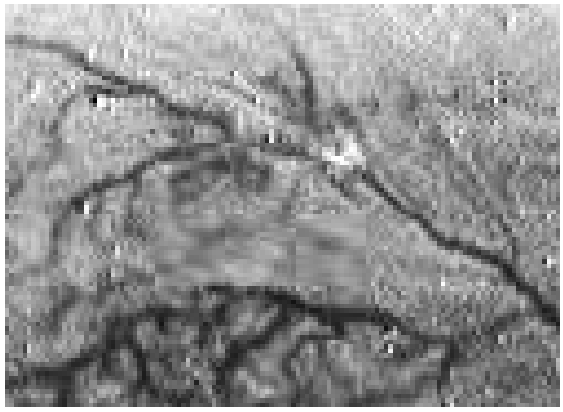

Figure 1: Bottom image of triplet 541a. (Image: ESA/NASA/JPL/University of Arizona.)

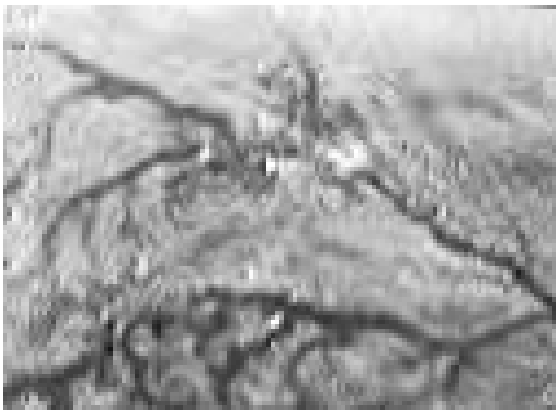

Figure 2: Bottom image of triplet 553a. (Image: ESA/NASA/JPL/University of Arizona.)

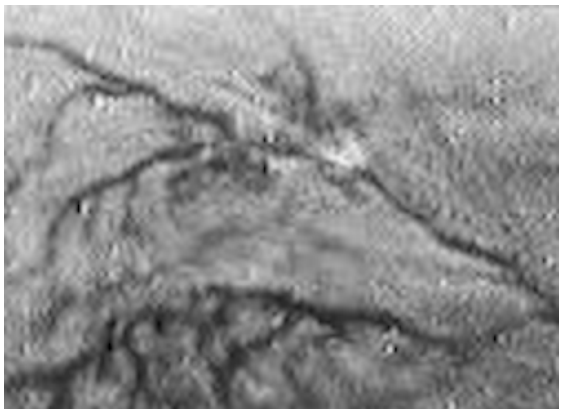

Figure 3: Doubled-resolution image based on Figures 1 and 2.

3. Future work

This technique will allow us to have a closer look at the surface of Titan.

Apart from the super-resolution of Huygens descent imagery, we are beginning similar work on Cassini SAR images of this and other drainage networks, so that we will be able to perform their morphometrical characterization and subsequent comparison with Terrestrial analogues.

References

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