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Supporting lander and rover operation: a novel super-resolution restoration technique

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Higher resolution imaging data is always desirable to critical rover engineering operations, such as landing site selection, path planning, and optical localisation. For current Mars missions, 25cm HiRISE images have been widely used by the MER & MSL engineering team for rover path planning and location registration/adjustment. However, 25cm is not high enough resolution to be able to view individual rocks ($\leq$2m in size) or visualise the types of sedimentary features that rover onboard cameras might observe. Nevertheless, due to various physical constraints (e.g. telescope size and mass) from the imaging instruments themselves, one needs to be able to tradeoff spatial resolution and bandwidth. This means that future imaging systems are likely to be limited to resolve features larger than 25cm.

We have developed a novel super-resolution algorithm/pipeline to be able to restore higher resolution image from the non-redundant sub-pixel information contained in multiple lower resolution raw images [Tao & Muller 2015]. We will demonstrate with experiments performed using 5-10 overlapped 25cm HiRISE images for MER-A, MER-B & MSL to resolve 5-10cm super resolution images that can be directly compared to rover imagery at a range of 5 metres from the rover cameras but in our case can be used to visualise features many kilometres away from the actual rover traverse.

We will demonstrate how these super-resolution images together with image understanding software can be used to quantify rock size-frequency distributions as well as measure sedimentary rock layers for several critical sites for comparison with rover orthorectified image mosaic to demonstrate optimality of using our super-resolution resolved image to better support future lander and rover operation in future. We present the potential of super-resolution for virtual exploration to the $\approx$400 HiRISE areas which have been viewed 5 or more times and the potential application of this technique to all of the ESA ExoMars Trace Gas orbiter CaSSiS stereo, multi-angle and colour camera images from 2017 onwards.

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