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GENERAL ARCHITECTURE FOR UNSUPERVISED SINGLE-IMAGE SUPER-RESOLUTION OF SINGLE BAND NANO-SATELLITE: BGUSAT VIA IMAGE-SPECIFIC FEATURE EXTRACTION

Abstract

BGUSAT, the first Israeli research CubeSat, is a nanosatellite joint venture between Ben-Gurion University of the Negev, IAI (Israel Aerospace Industries) and ISA (Israeli Space Agency). It is a Low Earth Orbit (LEO) 3U CubeSat imaging Earth in the Short Wave Infra-Red (SWIR) spectrum. The satellite has been fully operational since Feb. 15th, 2017, and has already collected many images of the Earth, claiming mission success for the technology part. Image enhancement is highly required for further data capacity and valuable intelligence extraction from the acquired images that are already at 600m spatial resolution. Image super-resolution is a continuously demanding topic in the computer-vision community in recent decades and has witnessed impressive applications on increasing spatial resolution in every field such as medical, agriculture, remote sensing, defense security and many more applications. Further, deep learning-based image super-resolution methods have shown tremendous improvement in reconstruction performance. However, most of the recent state-of-the-art deep learning-based methods for image super-resolution assumes an ideal degradation kernel (like bicubic down-sampling) on standard datasets. These approaches perform poorly on real-world satellite images in practice as real degradations are far away and more complex in nature than pre-defined assumed kernels. With this drawback in mind, various

state-of-the-art kernel estimation-based methods have evolved via iterative approaches like Iterative Kernel Correction (IKC), Internal- GAN (InGAN) and Correction filter for blind super-resolution. However, iterative kernel estimation-based approaches are not only time consuming, but also require complex objective functions along with regularization. Motivated by this real-time challenge, our idea is to enhance the resolution particularly for images from BGUSat-a nano-satellite, that is currently at 600m spatial resolution, implicitly defines an image-specific feature in an iterative way without defining any fixed explicit degradation for image super-resolution. Besides, we also discuss why and how our method is superior to other unsupervised methods via a comparative study based on image quality assessment. The latter is done both qualitatively (vision based) and quantitatively without recurring to a reference image for quality assessment. The proposed method outperforms state-of-the-art approaches by incorporating domain knowledge from recently implemented unsupervised single image blind super-resolution techniques.