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SUPER RESOLUTION CNN FOR A QUINCUNX SAMPLING-BASED PANCHROMATIC EARTH OBSERVATION IMAGER FOR NANOSATELLITES

Abstract

High-resolution satellite imagery is a key requirement for a wide range of earth observation applications, such as environmental monitoring for geoscience, forecasting, and land use analysis. Due to the optics and sensor technology limitations, the spatial resolution may not satisfy the desired requirements. We propose a new super-resolution imaging method based on a dynamic camera focal plane and a CNN (Convolutional Neural Network) -based post-processing algorithm for image resolution and quality enhancement. A highly accurate piezoelectric actuator shifts the focal plane by half a pixel, enabling the camera sensor to acquire two panchromatic images with a sub-pixel offset, along both row and column directions. Adopting the quincunx sampling scheme, a high-resolution image is obtained by interleaving the two images and reconstructing the missing pixel information with a new Neural Network model. Our network inferences the best function that interpolates the pixels, increasing the output image resolution. For this purpose, an image dataset is built to simulate the data acquired by our imaging method, starting from the 0.31m GSD (Ground Sample Distance) resolution panchromatic products provided by the WordView-3 satellite. When using very small satellites for earth observation, such as a nanosatellite, the spatial resolution is limited by the mass and volume constraints which results in a limited focal length. The proposed method can be adopted on board very small satellites, to significantly increase the performance in spatial resolution given the same focal length, with a better SNR (Signal to Noise Ratio) respect to the other super-resolution techniques. The feasibility of the proposed method is demonstrated by means of numerical simulations and experimental results.