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A LIGHTWEIGHT SUPER-RESOLUTION RECONSTRUCTION METHOD FOR LOW-LIGHT SPACE TARGET OBSERVATION IMAGES

Abstract

With the development in space science and technology, space target observation tasks have become an indispensable component of space missions and acquiring high-resolution (HR) images is the key for accomplishing target observation tasks. However, obtaining HR space target observation images directly is challenging due to the extreme light environment in space, limitations of on-board equipment, and high-speed movement of space targets. In recent years, with the development of super-resolution (SR) reconstruction methods, particularly the emergence of SR reconstruction technology based on deep learning, it has become possible to recover more detailed textures and high-frequency information from low-resolution (LR) images. However, researches on SR methods for low-light and unevenly illuminated spatial environments are still relatively scarce. Noteworthily, most of these methods have large number of parameters, flops, and running-time, which are not appropriate for on-board computers and space target observation tasks. Therefore, a lightweight SR reconstruction method for low-light space target observation images named pyramid color-recovery and adaptive kernel selection network (PCAKSN) is proposed in this article. This network is composed by several state-of-the-art attention modules and blocks such as the pyramid adaptive lightening and darkening operation block (PALDB) for enhancing the distribution of brightness, contrast and illumination in target observation images and the pyramid adaptive large kernel selection module (PALKSM) to capture more useful features and high-frequency information. Additionally, aiming at evaluating the performance of our method, a low-light space target observation images dataset (LL-STOID) is built by us. Experimental results on benchmark datasets (Set5, Urban100, BSD100 and LOL) and self-built LL-STOID demonstrate that our PCAKSN outperforms in performance, parameters and running-time in low-light images and can be deployed on spacecrafts for improving the quality of target observation tasks particularly in low-light conditions.