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Image restoration experiment for infrared images of Venus

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Thermal infrared images captured by Longwave Infrared Camera (LIR) onboard Akatsuki provide valuable information about the dynamics of the Venusian atmosphere. LIR successfully detects thermal emission in a waveband 8-12 μm from the cloud deck of Venus on dayside and nightside with equal quality[1]. However, the noise in the infrared images prevents from further investigation of the Venusian atmosphere. Enhancement of the image quality is thereby needed to reveal more detailed morphology and structures of clouds.

Image restoration has been a popular topic and extensively studied for decades. It is the task of recovering a true unknown image from a degraded observed one. Numerous traditional and deep learning methods have been developed and proven to be powerful in image restoration for fields like remote sensing[2], medical imaging[3], etc. Regarding the LIR images, the previous study reduced random noise by taking a moving average of successive images with an interval of a few hours[4,5]. Stable structures are thereby highlighted, while transient ones are suppressed simultaneously.

Therefore, this study seeks new approaches to enhance the remote sensing images while refraining the transient structures from reduction. We selected a traditional algorithm, BM3D, and a learning-based algorithm, KBNet, to restore the infrared images of Venus. Both methods provided distinguishable major cloud structures. Enhanced images were compared with the original infrared image and the moving averaged images. The noise power spectrum (NPS) of the results obtained by BM3D, KBNet, and moving average was produced to investigate the characteristics of the noise and demonstrate the reliability and effectiveness of the two methods in the restoration of LIR images. The comparative analysis provides insights into the performance and efficacy of the traditional and learning-based algorithms on the LIR images, which contribute to the image process routine and analysis of remote sensing of Venus in the future.

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