Application of mathematics and AI methods in Satellite Images

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Abstract

Satellite images are vital for numerous applications such as agriculture, urban planning, and environmental monitoring. The growing demand for enhanced image quality and accuracy has led to the application of mathematical methods and artificial intelligence (AI) techniques in satellite image processing, focusing on image enhancement, de-blurring, de-noising, and object recognition and classification.

Mathematical methods, including Image De-blurring, Image Contrast Enhancement, and Noise Removal with Blind Deconvolution, significantly improve satellite image quality, enabling the extraction of valuable information. The FORMOSAT-5 image processing system has incorporated de-blurring and de-noising technology. Since 2019, The Image Processing Division of Taiwan Space Agency (IPS-TASA) team has been continuously refining the processing system to achieve optimal image quality. This paper will introduce various de-blurring, de-noising and fusion techniques employed by the team. In addition, the team is working on enhancing the processing speed by exploring multi-threading methods to further improve user's need.

AI methods have demonstrated considerable potential in satellite image application, particularly in object recognition and classification. The IPS-TASA team employs AI techniques in applications such as:

(1) The Change of Taiwan West Coast: monitoring coastal changes to assess environmental impacts and identify trends for future planning.

(2) Rice Detection: identifying rice fields and monitoring growth stages to facilitate efficient agricultural practices.

(3) Aircraft or Ship Detection: detecting and tracking aircraft and ships for security, surveillance, and traffic management.

(4) Segmentation of Landscape and Cities: categorizing images into roads, urban and non-urban areas, and trees for urban planning, resource management, and environmental monitoring.

The Deep Network Training and Evaluation scheme, crucial for AI application in satellite imagery, will also be introduced. This scheme ensures their effectiveness and accuracy in processing satellite images.

As a result, the integration of mathematical methods and AI techniques has revolutionized satellite image processing, leading to improved image quality and valuable information extraction. The continuous development of these methods will contribute significantly to the understanding and management of our planet's resources and environment.