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SINGLE IMAGE SUPER-RESOLUTION OF MULTI-SPECTRAL SATELLITE IMAGERY USING DEEP LEARNING TECHNIQUES

Abstract

Earth observation (EO) satellites are an important source of data when it comes to monitoring the Earth and deriving decisions based on EO data. Satellite images have many applications that include but are not limited to agriculture, forestry, landscape analysis, oceanography, geology, mapping, and environmental assessment.

However, despite advancements in satellite imaging technology, challenges persist in obtaining high-resolution imagery. Low to medium satellite images have advantages like being freely available and historical data with global coverage, however a low level of detail with only large features visible makes it impossible to use them on specific applications such as detecting objects, or precision agriculture. To mitigate this problem, super-resolution algorithms aim to synthesize higher-quality images with improved resolution and detail from the low-resolution ones.

Generative Adversarial Networks (GANs) and Denoising Diffusion Probabilistic Models (DDPMs) showed impressive results on image generation problems. GANs are highly effective in generating details and textures, but GANs' training is not stable and can be quite challenging. On the other hand, DDMPs are more stable during training and can achieve high-fidelity results, while, computational cost can be higher. Furthermore, with the emergence of new transformer-based diffusion models, the generated image quality and resolution increase are remarkable. For image super-resolution tasks, both GANs and Diffusion models have been successfully applied with promising results, each offering distinct advantages and disadvantages. However, in the field of satellite images, GANs have been explored for super-resolution, but DDPMs' capabilities are under-researched.

In this work, we investigate the capabilities of both approaches. We demonstrate the effectiveness of our proposed model by evaluating it on datasets acquired through Azersky and Sentinel-2. We aim to assess the performance of both models in terms of visual quality, quantitative metrics, and computational efficiency, analyzing their strengths and weaknesses in the context of satellite image super-resolution. Our initial research indicates that resolution-increased images can be used for more accurate and detailed information extraction and add value to low-resolution images.