The Role of AI and Deep Learning Methods in Enhancing Satellite Remote Sensing Data Affected by Cloud Cover

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Introduction

Satellite imagery provides valuable information about Earth's surface and atmosphere, but it is often limited by cloud coverage. Advances in AI offer promising solutions for cloud detection and image reconstruction.

Environmental Applications

Natural Hazards
Wildfires, floods, and droughts.

Weather Forecasting
Atmospheic conditions & weather patterns.

Climate Change
Tracking climate changes.

Vegitation Monitoring
Health, growth, & changes in land cover.

Problem Statement

Cloud cover limits the reliability and usability of satellite imagery by reducing:

- the visibility of the Earth's surface,
- the quality of the images,
- the accuracy of the measurements,
- the availability of clear data.

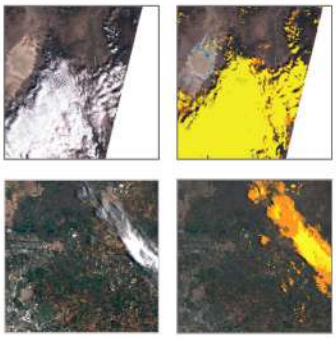


AI / Deep Learning

Fully Convolutional NNs

Pixel-level cloud detection and segmentation using spatial features.

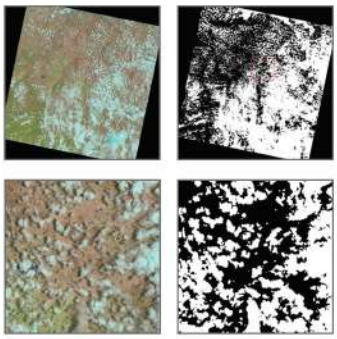
Representative model: MF-CNN
Application: Cloud Detection



Encoder–Decoder NNs

Multi-level feature extraction for accurate cloud segmentation.

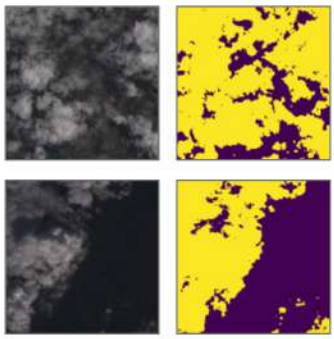
Representative model: U-Net(++)
Application: Cloud Segmentation



Attention-Based NNs

Focus on the most relevant image regions and features.

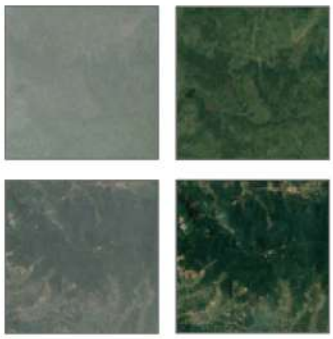
Representative model: Cloud-AttU
Application: Cloud Detection



Generative Adversarial NNs

Reconstruct missing or cloud covered regions, improve image completeness.

Representative model: GANFilling
Applic.: Cloud removal & reconstracting

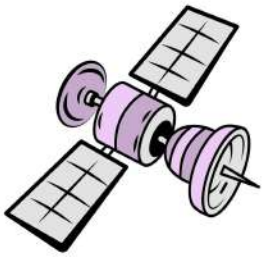


Fully Convolutional Neural Nets → Pixel-Level Classification
Encoder-Decoder Neural Nets → Feature Extraction & Segmentation
Attention-Based Neural Nets → Enchanced Cloud Detection
Generative Adversarial Nets → Satellite Image Reconstruction

Discussion

- FCN & Encoder–Decoder: Cloud detection and segmentation.
- Attention-based: Focus on relevant image features, improving cloud identification.
- GAN-based models: Reconstr uction of missing or cloud-covered image regions.

However, reliability depends on image quality, atmospheric conditions.



Conclusions & Future Perspectives

- AI and Deep Learning can improve the usability of cloud-affected satellite imagery.
- Future research should integrate satellite observations, ground-based measurements, and AI models.

Key Sources

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