URSI GASS 2020, Rome, Italy, 29 August-5 September 2020

Deep-learning techniques for cloud pixel removal from multispectral satellite images

Amiya K. Sahoo* [(1)], Ajay K. Gogineni[(2)], D. Swain[(1)]and Kisor K. Sahu[(2)]
(1) School of Earth, Ocean and Climate Sciences, Indian Institute of Technology Bhubaneswar-752050, INDIA;
e-mail: aks21@iitbbs.ac.in; dswain@iitbbs.ac.in
(2) School of Minerals, Metallurgical & Materials Engineering
Indian Institute of Technology Bhubaneswar-752050, INDIA; akg11@iitbbs.ac.in; kisor@iitbbs.ac.in

Land use land cover change analysis is an important area of research in weather and climate. The major source of data for this is images provided by satellites. But, many times, clouds act as noise for these images. In this work, we have attempted to remove cloud pixels using Generative Adversarial Networks (GAN) with U-Net as a generator and further optimized using Feature loss, Gram loss and Mean Squared Error (MSE) loss. For this Landsat-8 data with a spatial resolution of 30 m was used. False Colour Composite FCC) images were generated by staking 3 bands together as Red (R), Green (G) and Blue (B) into stacking band combinations like (4,3,2), (5,4,3), (6,5,2), etc. Earlier, an information cloning technique to remove clouds was proposed in [1] and Perceptual loss in [2], where the loss function of the Generator is modified by using high-level features extracted from pre-trained networks. Two sets of images were used for training the neural network. Two images were taken from two different dates within a 15-day interval from the same geographic location with the assumption that land cover did not change significantly over a short period of time. The image containing less clouds(less than 10%) was considered as ground truth and the corresponding image pair with higher amount of clouds(more than 30%) was considered as noisy images. 7500 images of size 128 pixels x 128 pixels were generated from the FCC images of each image. Images very close to the target (ground truth) image could be generated from the noisy images by the generator. The limit of the cloud percentage in the noisy image was found to be less than 40% for the success of this method.

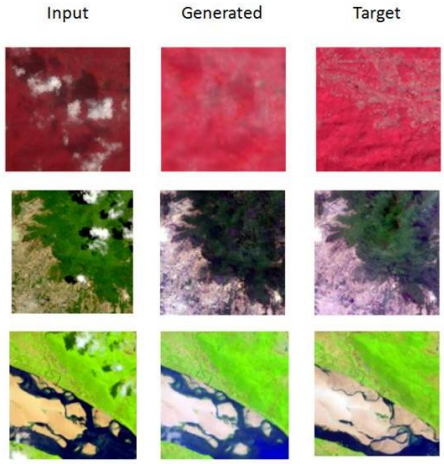

Figure 1. Cloud removal using GAN and Feature loss technique. Input image, Generated image and Taget Image (Ground truth) are shown above [Should be seen from left to right].

For assessing the generated images post cloud removal, a set of images were selected consisting of the major types of Land Covers. The average Mean Square error was found to be 3.56%. The average Structural Similarity Index (SSIM) value was found to be good at 0.66 for SSIM ranging -1 to 1. This validated the use of such an approach for cloud removal from multispectral Landsat- imagery.

1. Menaka, E., Kumar, S. S., & Bharathi, M. (2015). Cloud removal using efficient cloud detection and removal algorithm for high–resolution satellite imagery. *International Journal of Computer Applications in Technology*, *51*(1), 54-61.
2. Johnson, J., Alahi, A., & Fei-Fei, L. (2016, October). Perceptual losses for real-time style transfer and super-resolution. In *European conference on computer vision* Springer, Cham. (pp. 694-711).
3. Lin, C. H., Tsai, P. H., Lai, K. H., & Chen, J. Y. (2012). Cloud removal from multitemporal satellite images using information cloning. *IEEE transactions on geoscience and remote sensing*, *51*(1), 232-241