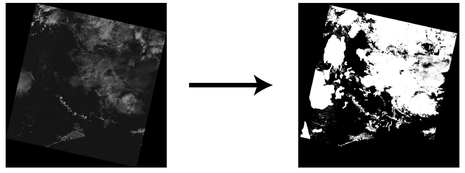
CLOUDMASKGAN: A Content-aware Unpaired Image-to-image Translation Algorithm for Remote Sensing Imagery

Sorour Mohajerani , Reza Asad , Kumar Abhishek , Neha Sharma , Alysha van Duynhoven , Parvaneh Saeedi
Simon Fraser University, BC, Canada

Why?

Cloud segmentation is a vital task in applications that utilize satellite imagery. Cloud regions in satellite images hold valuable information about the atmospheric parameters in weather studies.



Problem: Unlike many other computer vision tasks, collecting additional data and relevant ground truths is unfeasible.

A Solution: Generating synthetic satellite imagery.

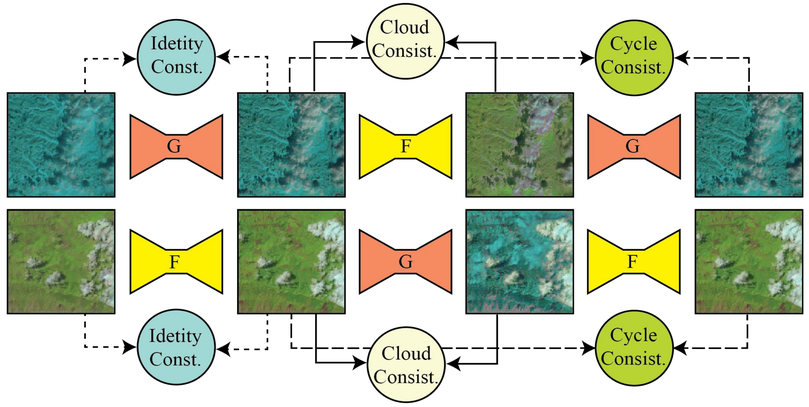
What should the synthetic images look like?!

- Exhibit **realistic appearances** with the original training images in texture, style, etc.
- **Location and intensity of clouds** should remain **intact**, so that the existing ground truths can be reused in further cloud detection algorithms.

Some important points:

- Distinguishing clouds from snow/ice is difficult.
- To have diverse and challenging images: Converting snowy landscapes to non-snowy ones, and vice versa.

How?



$$G: X(non-snow) \rightarrow Y(snow), F: Y(snow) \rightarrow X(non-snow)$$

Discriminator D_Y tries to distinguish between real images of y and the translated versions, G(x).

Loss functions for training:

$$L(G,F,D_Y,X,Y,M_X,M_Y) = L_{GAN}(G,D_Y,X,Y,M_X,M_Y) + \lambda_1 L_{identity}(F,X,M_X) + \lambda_2 L_{cyc}(G,F,X,M_X) + \lambda_3 L_{cloud}(G,X,M_X)$$

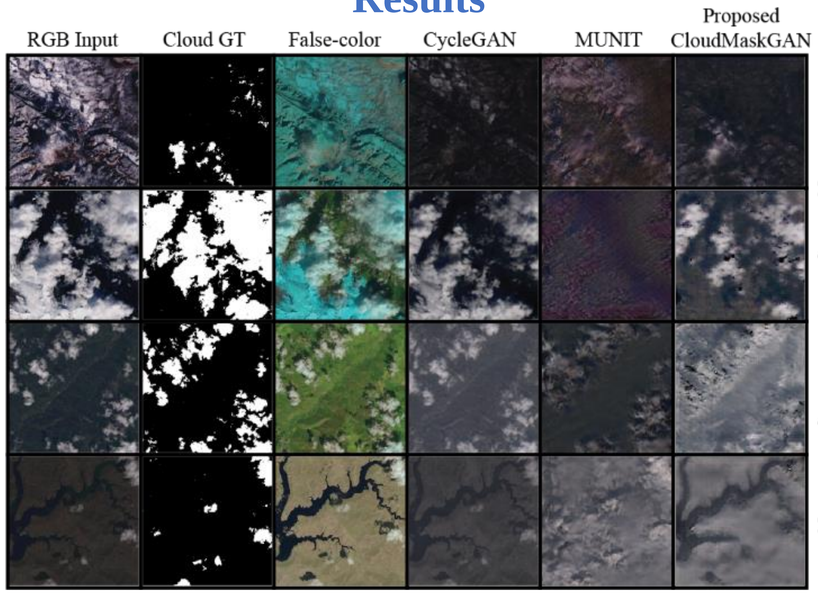
$$L_{GAN}(G,D_Y,X,Y,M_X,M_Y) = E_{y\sim p_{(y)}}[log(D_Y(y * M_Y)] + E_{x\sim p_{(x)}}[log(1 - D_Y(G(x) * M_X)]$$

$$L_{identity}(F,X,M_X) = E_{x\sim p_{(x)}}[\|F(x) * M_X - x * M_X\|_1]$$

$$L_{cyc}(G,F,X,M_X) = E_{x\sim p_{(x)}}[\|F(G(x)) * M_X - x * M_X\|_1]$$

$$L_{cloud}(G,X,M_X) = E_{x\sim p_{(x)}}[\|G(x) * (1 - M_X) - x * (1 - M_X)\|_2]$$

Results



Method	Jaccard	Precision	Recall	Overall Accuracy
CycleGAN GAN-train	26.17	54.14	38.56	69.09
MUNIT GAN-train	-	-	-	31.21
CloudMaskGAN GAN-train	**46.24**	**66.50**	**68.57**	**84.36**
CycleGAN GAN-test	10.76	21.49	37.60	39.14
MUNIT GAN-test	15.17	33.25	42.35	61.86
CloudMaskGAN GAN-test	**27.57**	**47.05**	**49.96**	**74.80**

Conclusion

CloudMaskGAN generates realistic synthetic remote sensing images.

By incorporating ground truths, CloudMaskGAN provides a translation approach that can be extended to other computer vision tasks.

Given imbalanced or limited datasets (and ground truths), CloudMaskGAN has the potential to generate high-quality and diverse synthetic data that can retain pixel values in specific regions.

Contact: e-mail: smohajer@sfu.ca, Laboratory for Robotic Vision (LRV), School of Engineering Science, Simon Fraser University