# Urbanization Detection

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## Problem statement

Urbanization detection using computer vision algorithms to reduce the reliance on the data of government surveys, which will speed up the policy making process.

## Motivation

Rapid change in the landscape of the earth is taking place in the form of Urbanization. The flora is being wiped out at a very fast pace and replaced by the concrete jungles.This generally depreciation reports by government surveys, and these surveys are time taking process and requires human labour, which inadvertently creates a lag in the precautionary and remedial policies. The proposed project intends to develop a full fledged system to detect the change in urbanization using satellite images and computer vision algorithms.

## Objectives

- To get a cost effective and efficient method to detect urbanization.
- Develop the deep learning Siamese segmentation network to detect the change in images.

## Literature Review

The research in the Urbanization detection talks about the use of Onera Satellite Change Detection (OSCD) dataset to do the pixel-wise segmentation using the Early Fusion and the Siamese Network. Since the dataset contains only 24 multispectral satellite images, the need for a better network which uses this small dataset efficiently was fulfilled by the works of **Papadomanolaki M. et al.** which used U-Net for feature representation and LSTMs for temporal modelling. This produced improved results and a better use of a small dataset. [1, 2]

## Dataset Description

*Onera Satellite Change Detection* (OSCD) dataset is used containing the images based on urban growth, captured from Sentinel-2 satellite, as shown in Figure - 1 [2].

- It contains 24 image pairs with resolutions between 10mm-60mm, having 13 spectral bands between Ultraviolet and Short-length Infrared.
- 14 pairs with their ground truths are used for training and rest 10 for testing.

Figure 1: Some the images from OSCD Dataset[2]

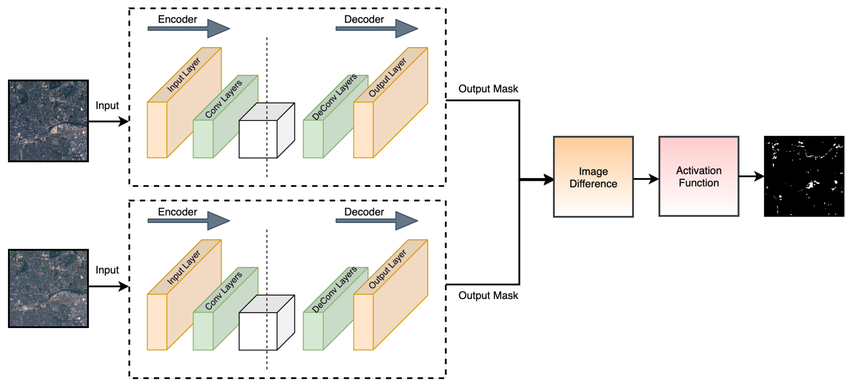


Figure 2: Architecture of proposed Siamese U-net network for urbanization detection algorithm

## Baseline Algorithm

- The difference of both the input images is passed through the PCA algorithm.
- Eigen Values and Eigen Vectors obtained by PCA are passed as the feature vector space to the KMeans clustering algorithm.
- Two clusters are obtained from KMeans, namely, change and no change (Figure - 3 (b)). The output change map is thus created.

## Proposed Algorithm

- Input is prepared by choosing random patches from the images, so as not to lose important information and get a sufficient number. The number of channels is decided appropriately.
- VGG16 pre-trained on ImageNet is used as an encoder to Siamese U-Net.
- The pair of Before and After image patches are passed through 2 separate Siamese U-Nets with shared weights.
- The difference of the two output masks is calculated and passed through the Sigmoid layer. The results are then compared with the ground truths and analysed.

## Results

Table 1: Results on PCA + K-Means and Siamese U-Net Segmentation Algorithm.

| Algorithm | Precision | Recall | IOU |
|---|---|---|---|
| Siamese U-Net | 0.656 | 0.821 | 0.574 |
| PCA+KMeans | 0.424 | 0.391 | 0.254 |

## Result Visualization

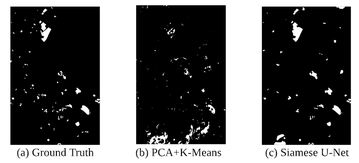


Figure 3: Result images from PCA + K-Mean and Siamese U-Net algorithm.

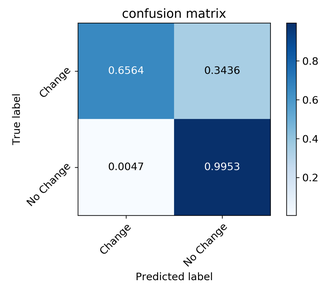


Figure 4: Confusion matrix of the Siamese U-Net on Mumbai city.

## Analysis and Conclusion

- An urbanization detection algorithm using Siamese U-Net architecture is presented.
- A good IOU of 0.57 is obtained which improves significantly on the baseline approach (IOU 0.25).
- The experimental results showcase that a properly designed deep learning can potentially provide a scalable solution.

## References

[1] O. Ronneberger, P. Fischer, and T. Brox, "U-net: Convolutional networks for biomedical segmentation," *CoRR*, 2015.

[2] R. Caye Daudt, B. Le Saux, A. Boulch, and Y. Gousseau, "Urban change detection for multispectral earth observation using convolutional neural networks,"

[3] M. Papadomanolaki, M. Vakalopoulou, S. Zagoruyko, and K. Karantzalos, "Benchmarking deep learning frameworks for the classification of very high resolution satellite multispectral data.," *ISPRS*.