

# Urban Areas Change Detection Based on Multitemporal Sentinel Data and Fully Automatic Neural Networks Algorithms

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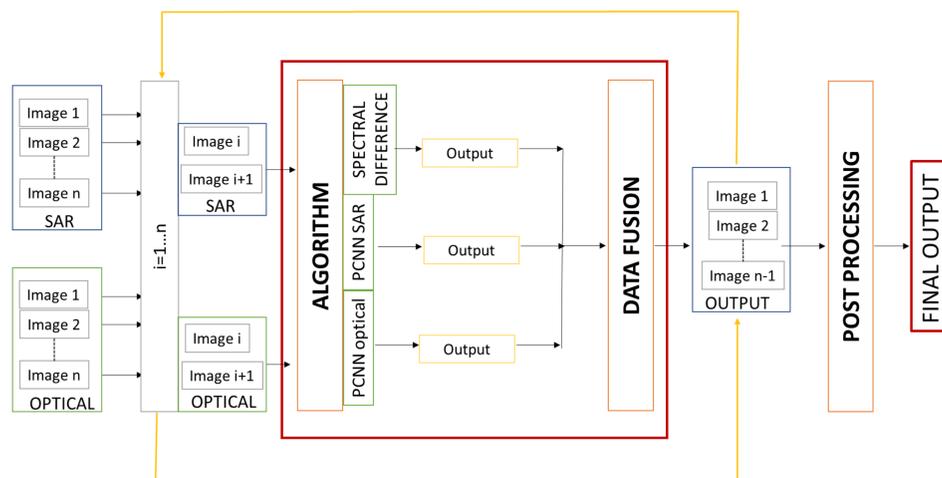


## INTRODUCTION

To control suburb's development and urban change detection is necessary to help political decision maker during territorial organization. Satellite remote sensing can be used to provide an objective and consistent view of urban areas. To reach this goal, we created a processing chain that uses an **iterative multitemporal approach** based on three procedures. The first and second ones are based on Pulse Coupled Neural Network (**PCNN**) applied to **C-band SAR images** provided by Sentinel-1 **and optical images** provided by Sentinel-2, respectively, while the third processing algorithm is an optical multiband filter, implementing spectral difference computations. The three procedure's outputs are computed at each temporal step and are then fused in order to create the final change detection map.

## ALGORITHMS AND METHODOLOGIES

The **multitemporal workflow**: After the pre-processing and the co-registration of the data the scheme implements iteratively three different procedures, identified as PCNN optical, PCNN SAR and Spectral Difference.

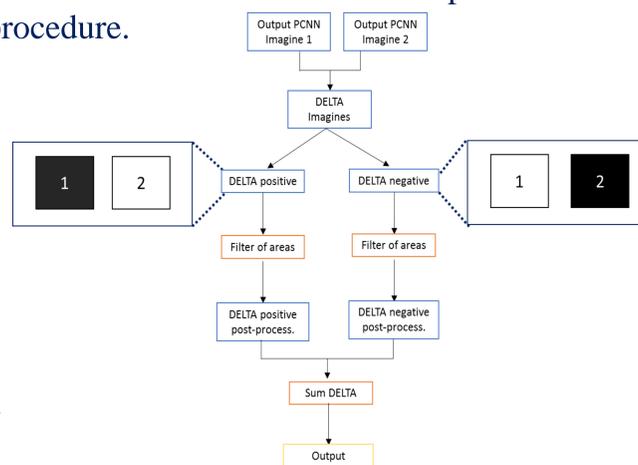


### PCNN OPTICAL AND PCNN SAR

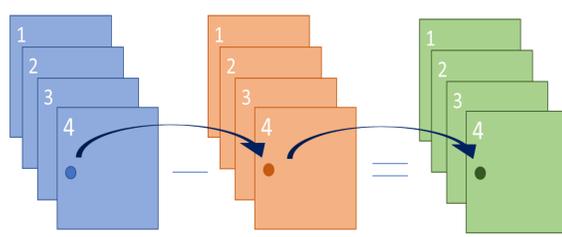
**PCNN Optical** and **PCNN SAR** can be executed in parallel and are based on the same procedure.

The outputs of the PCNN applied to the products acquired at  $t_1$  and  $t_2$ , are considered to compute the difference between each pixel's images resulting in positive and negative deltas.

After the computation of the deltas a further step is applied to implement an object recognition, useful to discard possible false alarms.



### SPECTRAL DIFFERENCE



$$(S1 - S2)sum[i][j] = \sum_b \sqrt{(I_{t_1}|_{i,j} - I_{t_0}|_{i,j})} / N$$

$$(S1)sum[i][j] = \sum_b \sqrt{I_{t_0}|_{i,j}} / N$$

$$(S1 - S2)sum[i][j] > (S1)sum[i][j] + (S1)sum[i][j] \cdot threshold$$

The **Spectral Difference** (SD) is an optical multiband filter that is applied only to multispectral data. The routine produces directly a change detection map. From two Sentinel-2 products acquired in two different times, we extract bands 2, 3, 4 and 8.

### DATA FUSION AND POST-PROCESSING

The **data fusion** uses a logical and approach based on pixel by pixel variation. If a pixel have the same final result in two of the three outputs, the change is true. The **post-processing** uses a multitemporal approach: if there is a permanent change between two images, the same change will be registered in subsequent times. For example, if in 3 of 5 subsequent images, the pixel's value is the same then the change is confirmed.

## EXPERIMENTAL SET UP

**ITALY:**

Ponte di Nona (Rome)  
Mezzocammino (Rome)

**EUROPE:**

Basel

## RESULTS

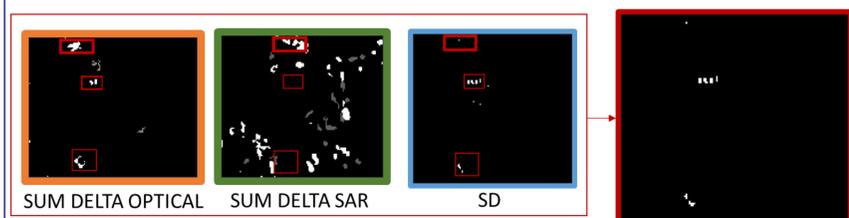
### CASE STUDY: PONTE DI NONA



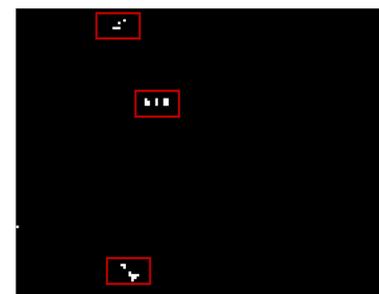
- A - 20/08/2015
- B - 21/04/2017
- C - 01/05/2017
- D - 11/05/2017
- E - 21/05/2017
- F - 31/05/2017

1. Construction of a railway station (top)
2. Construction of concrete platforms terminated on 11/05
3. Extension of a church (bottom)

### DATA FUSION: couple $t_0 - t_5$



### POST-PROCESSING FINAL DATA FUSION



Using the five couples, with multitemporal approach, the false alarms disappear, leaving only the real three changes.

## OVERALL RESULTS and CONCLUSIONS

Case study	Real changes	Detected changes
Basel	6	6
Ponte di Nona (Rome)	3	3
Mezzocammino (Rome)	4	4

- The procedure is fully automatic and unsupervised so no need of a training process.
- The results obtained over the considered test areas show a 100% success rate.