



INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

Department of Civil Engineering  
Geospatial Engineering

### **Project 3:**

**To apply spatial filters to a satellite remote sensing image**

Subject : CEN-612 Digital Image Processing

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Enrolment no. [REDACTED]

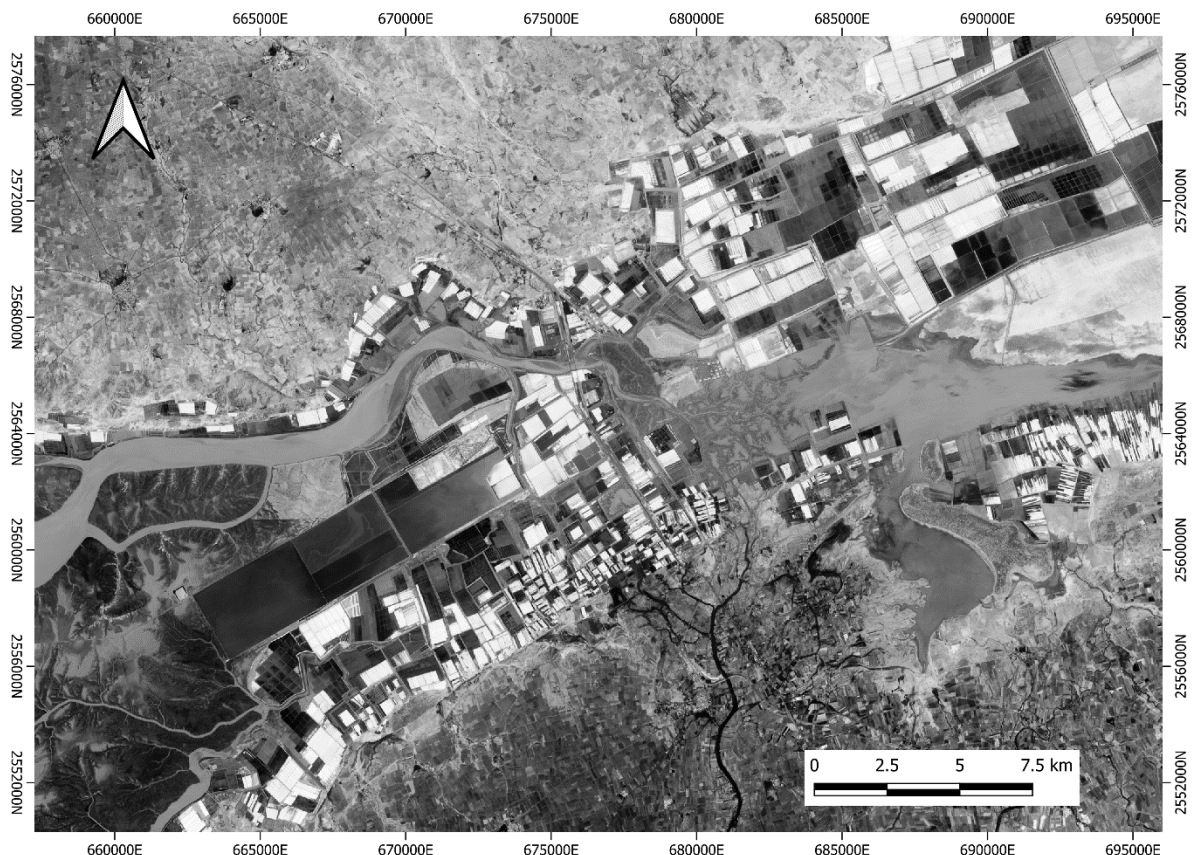
## 1. Introduction

Image enhancement algorithms are applied to remotely sensed data to improve the appearance of the image for visual analysis or to aid subsequent operations. One such category of operations are called spatial filtering operations, that deals with enhancing or subduing the spatial frequency enabling the extraction of useful information. One method of doing this is by using convolution masks or kernels. Many such spatial filtering techniques have been used here in this exercise to understand their working and significance in case of remote sensed data.

## 2. Study area

The study area is the Jamnagar district in Gujarat. The region has a lot of Reliance oil refineries and salt fields which makes it a good location for testing out different spatial filters. These fields and oil refineries have areas large enough for studying the effects of these operations on the features visible in the image.

## 3. Data and Methods



*Figure 1 Salt Fields in Jamnagar District of Gujarat*

Landsat-8 Collection-2 Level-1 data was used for the analysis. Panchromatic (Band-8) scene (path-150, row-044) having spatial resolution of 15m having was acquired from [earthexplorer.usgs.gov](http://earthexplorer.usgs.gov) for performing the spatial filtering exercise. Figure-1 shows the salt

fields in the region whereas in figure-2 oil refineries can be observed with white circular shapes.



*Figure 2 Oil refineries of Reliance in Jamnagar district of Gujarat*

Python and its various libraries (cv2, matplotlib, numpy, scikit, etc.) were used to perform different spatial filtering techniques on the above images. Sublime text editor was used for writing code.

#### 4. Results and Interpretation

##### Averaging/Mean filter:

In average filtering, pixel values will be replaced by average values of neighbour pixels. Figure-3 shows the increase in amount of blurring with the increasing size of kernel.

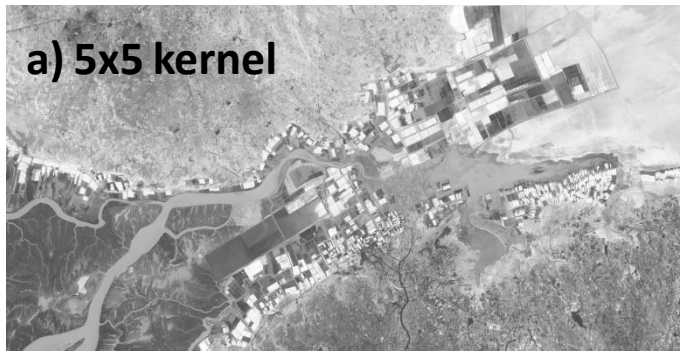
##### Laplacian filter:

Laplace smoothing technique is mainly used to detect image edges. It highlights grey level discontinuities. In figure-4 Laplacian edge detection filter has been used to derive edges.

Filter matrix:

[1, 4, 1]
[4, -21, 4]
[1, 4, 1]





*Figure 3 Averaging filter output images.*



*Figure 4 Laplacian Filter for edge detection*

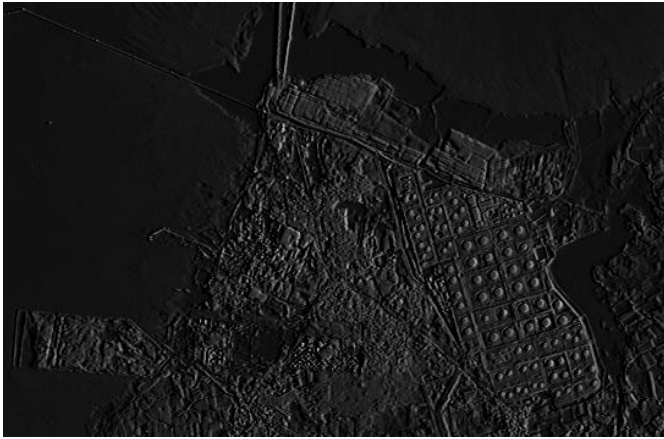
#### Emboss East and Northwest:

Used for edge enhancement by making edge appear in a plastic shaded relief format. The direction of the embossing is controlled by changing the opposite side values of the kernel.

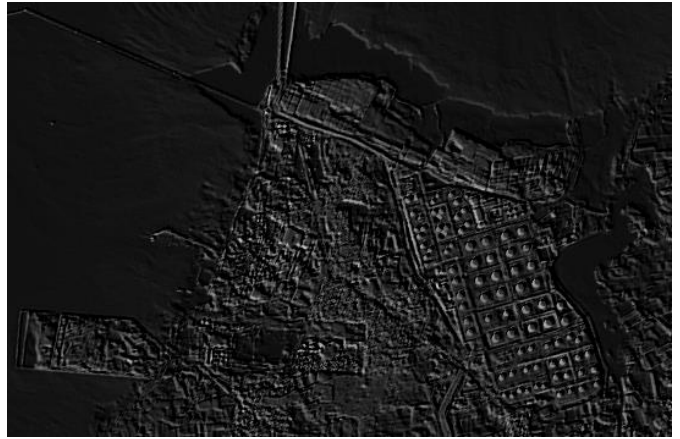
$$\text{Emboss East} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\text{Emboss NW} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ -1 & 0 & 0 \end{bmatrix}$$

In Figure 5, the embossing direction can be easily seen in the two images by observing the circular structures.



a) Emboss East



b) Emboss NW

*Figure 5 Emboss East and NW filter result on oil refinery field.*

#### Median:

This type of filter is best used for removing noise from the image for example – image having salt and paper noise. Here, the median value from the neighbouring pixels are used to replace the central pixel value. It can be used to remove the effect of unrepresentative values from the neighbourhood pixels.



*Figure 6 Median filter applied on the oil refinery field.*