Enhancement of breast cancer images

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Introduction

- Mammography is actually considered as one of the most efficient way for the detection of breast cancer at its first step.
- Microcalcifications and Clustered microcalcifications are known to be the first sign of a development of an eventual cancer. They appear as small and bright region with irregular shape in the breast. Their diversity in their shape, their directionality, their size and localisation in a dense mammogram confirm the major difficulty of their detection.
- The aim of the work is the development of a method for the detection of all type of microcalcifications.

Introduction (cted)

- The wavelet transform has emerged as a powerful tool for non-stationary signal analysis, its discrete version is closely related to filter banks and multiresolution signal analysis.
- the wavelet transform can separate small objects, microcalcification, from large background structure. The enhancement, hence the detection of the microcalcifications is assured for each different type by using for an appropriate wavelet coefficients.

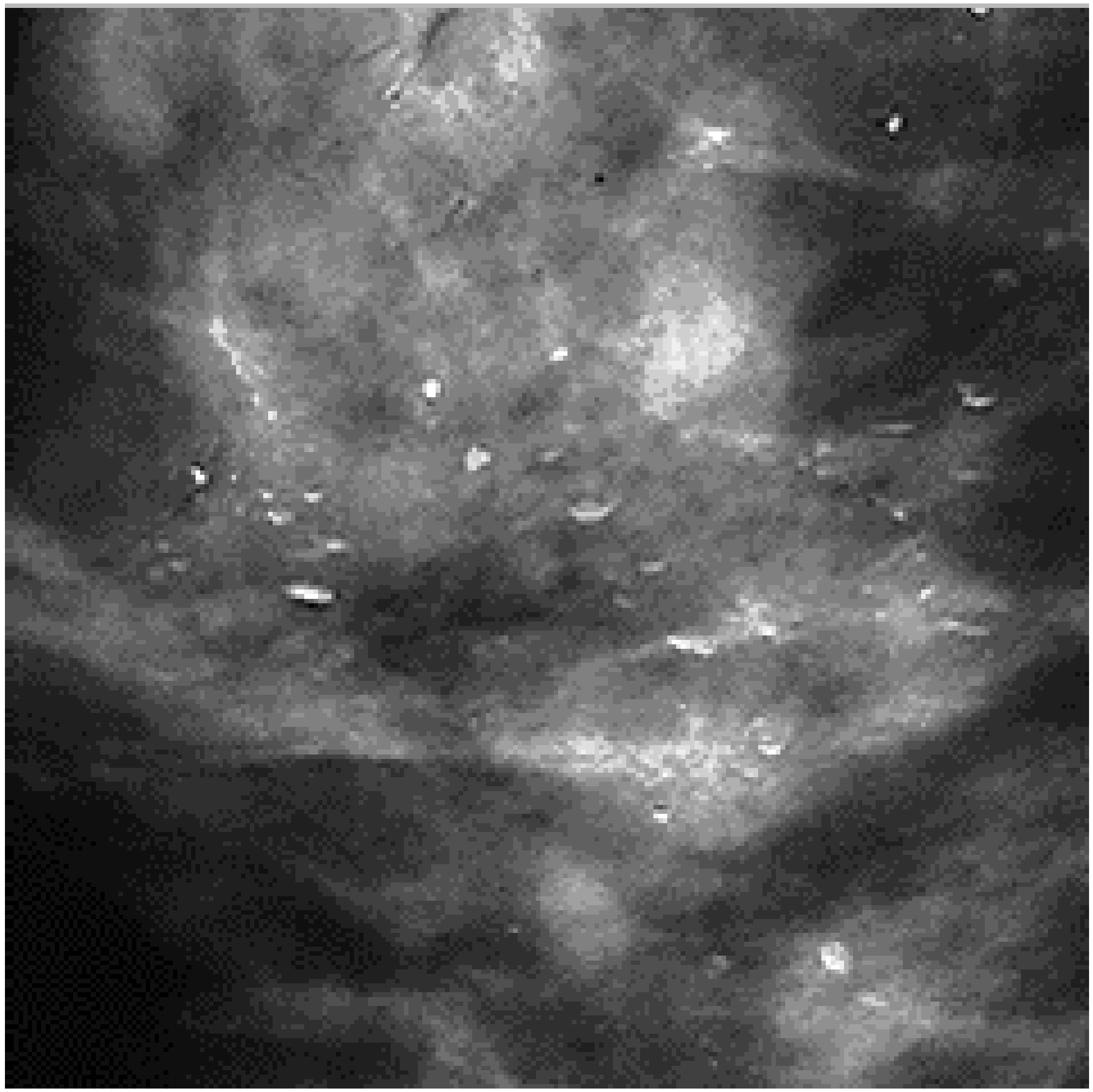

Figure 1: *micro-calcifications Type 1*

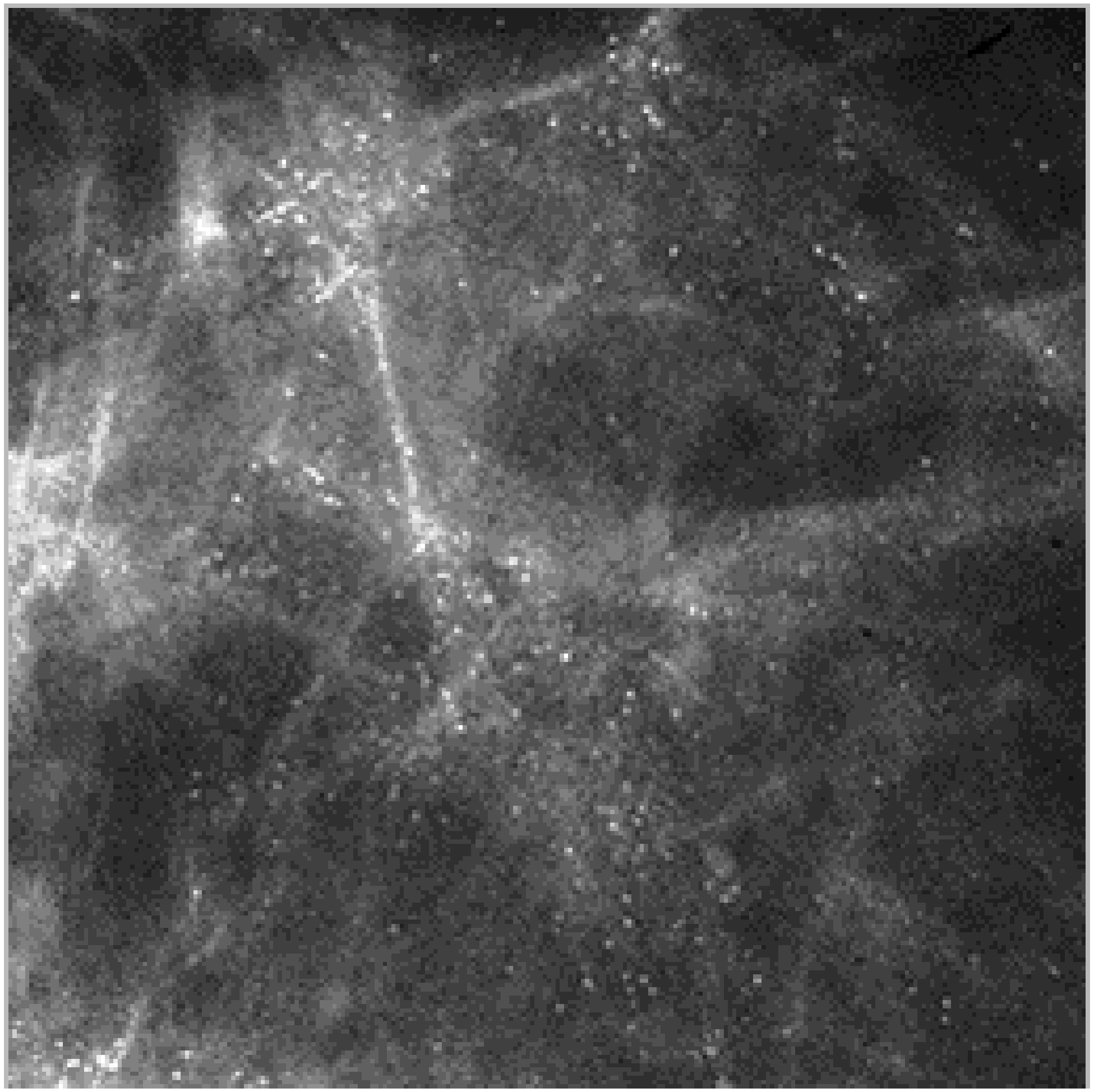

Figure 2: *micro-calcifications Type 4*

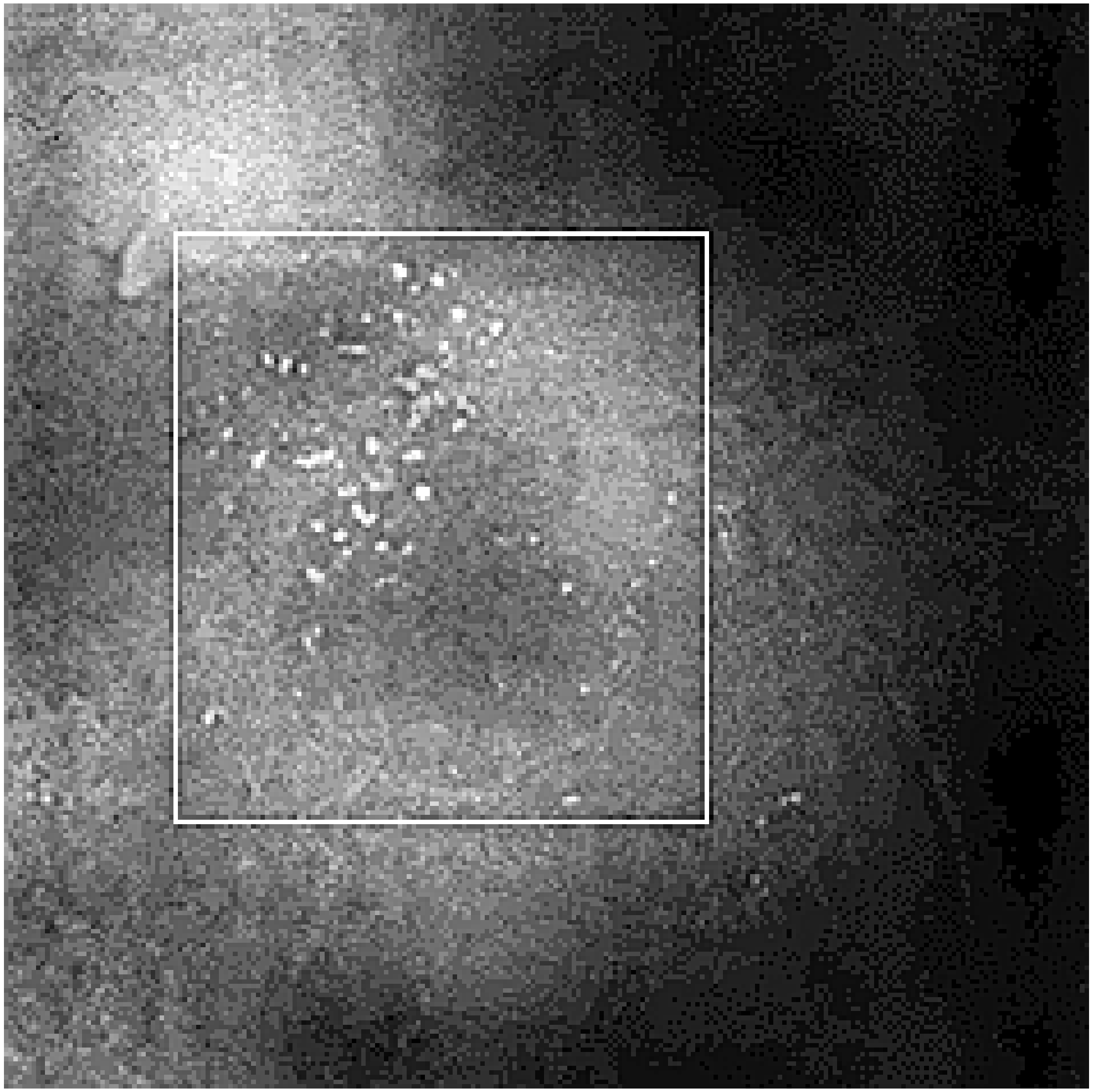

Figure 3: *micro-calcifications Type 5*

The Wavelet Transform

- $f(t)$ real function

$$g(a,b) = \frac{1}{\sqrt{a}} \int_{k=-\infty}^{k=\infty} f(t)\ \bar{\psi}_{a,b}(t)\ dt \qquad (1)$$

$a \neq 0$ $\psi_{a,b}(t)$ is obtained by translation et dilatation of a particular function Ψ called mother wavelet.

$$\psi_{a,b}(t) = \Psi(\frac{t-b}{a}) \qquad (2)$$

- b determines the position and a provides the scaling.
- The wavelet transform is linear.
- Function Ψ may have complex values.
- Many mother wavelets Ψ are possible (Haar, Daubechies, Morlet, etc...

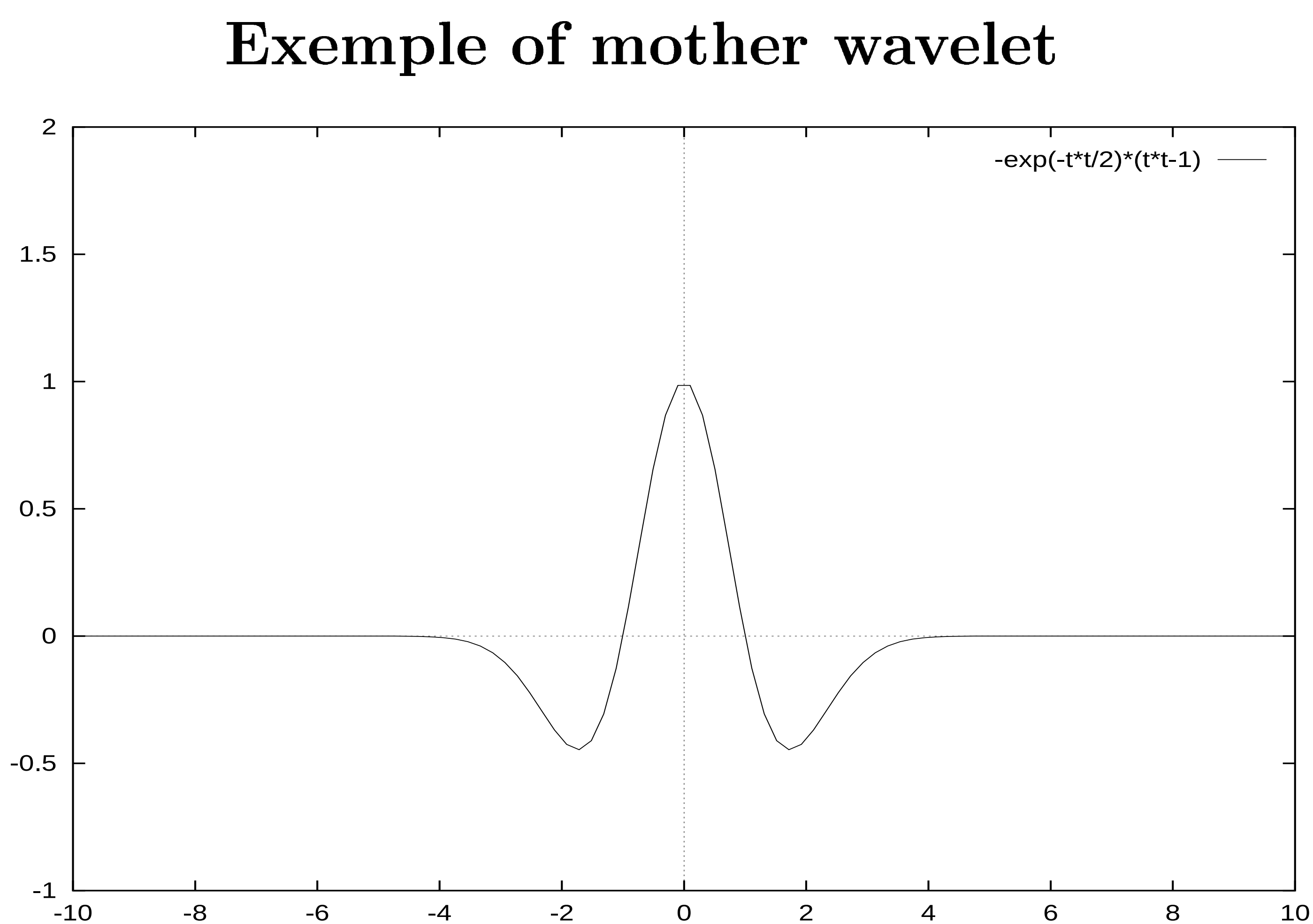

Figure 4: *Simple wavelet: Second derivative of a gaussian function*

Reconstruction of the original function

$f(t)$ can be reconstructed from $g(a, b)$ with the formula:

$$f(t) = \frac{1}{C_\psi} \int_{k=-\infty}^{k=\infty} \int_{k=-\infty}^{k=\infty} \frac{g(a,b)}{a^2} \psi_{a,b}(t)\, da\, db \tag{3}$$

C_ψ is a constant depending on the choice of $\Psi(t)$.

- The general wavelet transform is overdetermined.

Special case : The dyadic Transform

The basic functions are generated from the mother function by

- Dilatations with a factor $a = 2^i$
- Binary translations: for a given scale of dilatation i the translations are $b = j2^i$, j integer.

$$\psi_{i,j}(t) = \frac{1}{\sqrt{2^i}} \Psi\left(\frac{t-j2^i}{2^i}\right)$$

$$g(i,j) = \int_{k=-\infty}^{k=\infty} f(t)\, \bar{\psi}_{i,j}(t)\, dt \tag{4}$$

Each basic function $\psi_{j,i}(t)$ is caracterized by its width (scale) 2^i and its position j.

$g(i,j)$: Coefficients for frequency i and position j

This is also called multiresolution analysis.

Reconstruction (cted)

In the time-frequency representation, each basic function is almost contained in a rectangle of width 2^i in space and of width 2^{-i} in frequency

$f(t)$ can be reconstructed by :

$$f(t) = \sum_i \sum_j g(i,j)\ \psi_{i,j}(t) \tag{5}$$

- There exist fast algorithms comparable to FFT for the computation of the coefficients.
- It is thus possible to focus on low frequency objects (big shapes) or high frequency objects(details)

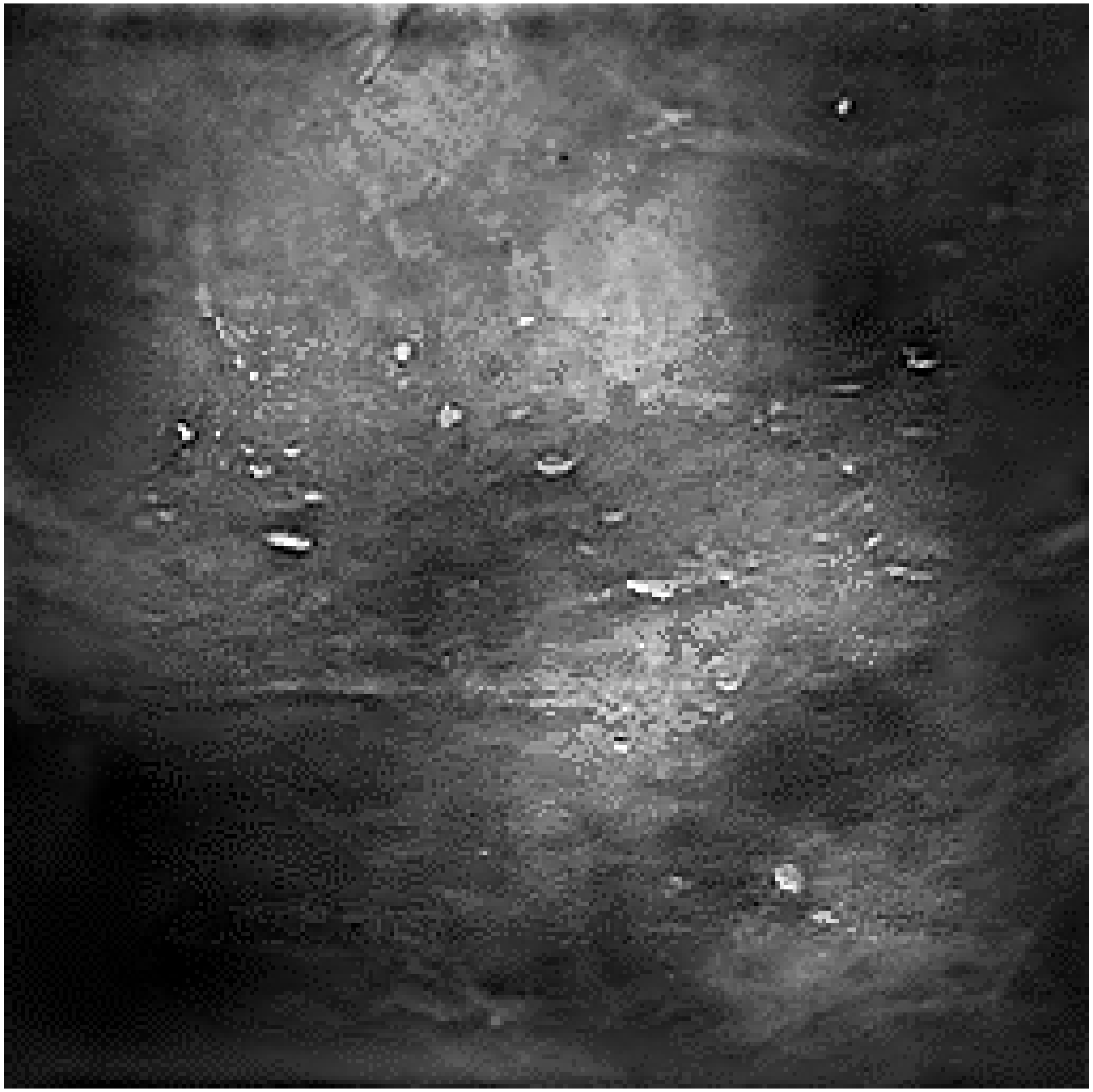

Figure 5: *micro-calcifications Type 1*

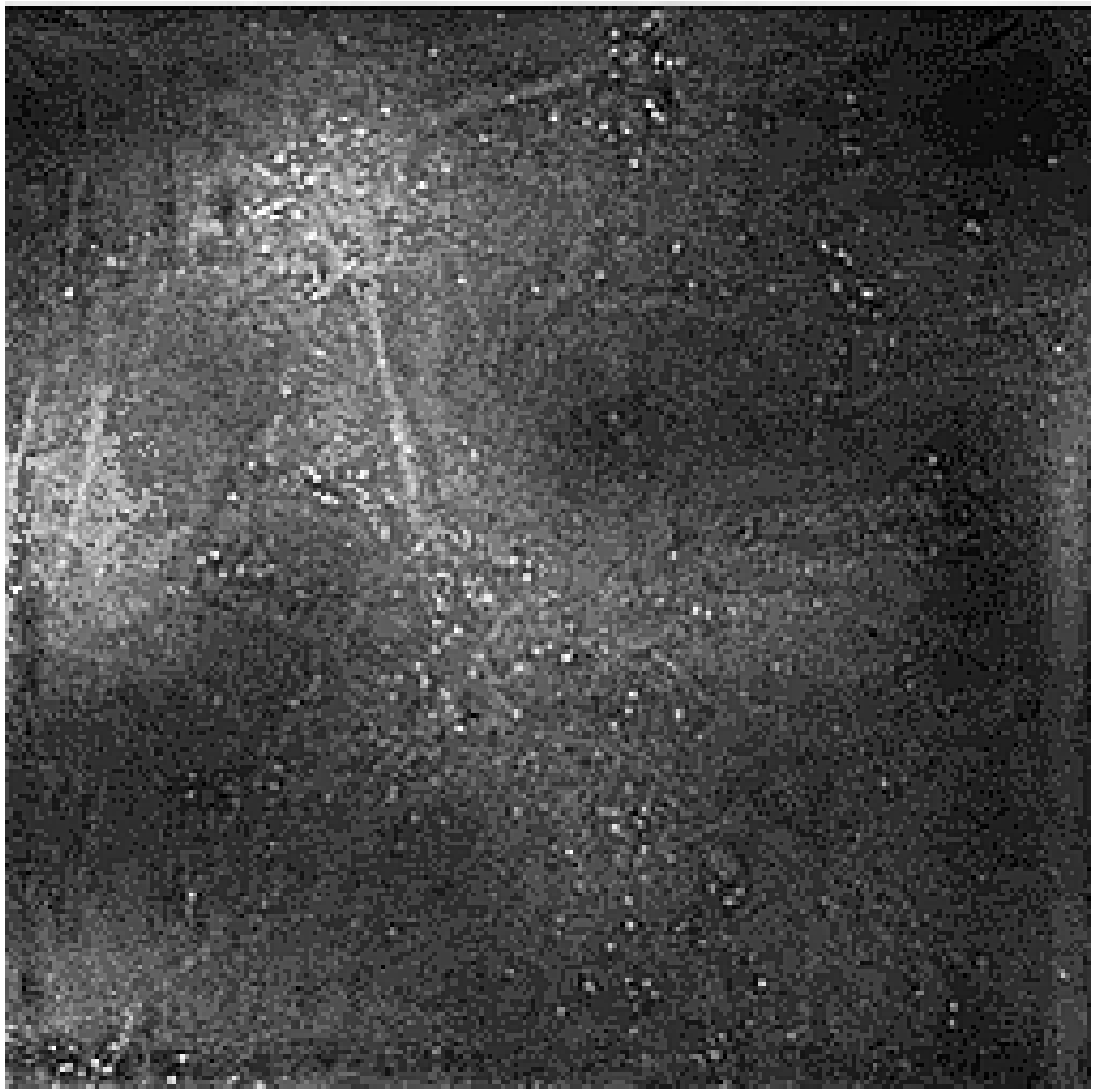

Figure 6: *micro-calcifications Type 4*

Conclusion

There is still some work to do