Granul 1.6

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Introduction

Granul is an implementation of correlation-based granulometry for circular shapes, described in [Kim2012].

Granul is intended to be executed in Windows 7. However, it probably can be executed correctly in other Windows environments, such as Windows XP and Windows Vista.

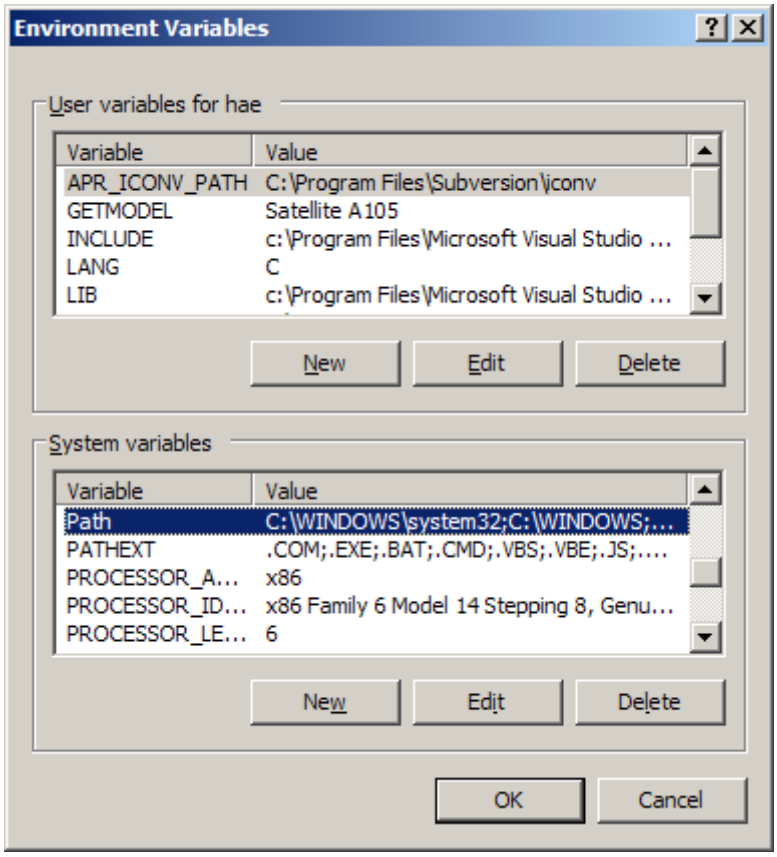
If you want to reference this program in your paper, please cite:

[Kim2012] H. Y. Kim, R. H. Maruta, D. R. Huanca and W. J. Salcedo, "Correlation-Based Multi-Shape Granulometry with Application in Porous Silicon Nanomaterial Characterization," *Journal of Porous Materials*, 2012 (to appear).

Installation

1) Uncompress granul16.zip in a directory, say, c:\granul.

2) Edit "path" environment variable to include c:\granul. This can be done at:
MS-explorer → my computer →(right click) properties → advanced properties → environment variables



Where path must be edited to include c:\granul.

3) Execute:

```
c:\directory>granul
```

Main program

Execute the following program:
```
c:\directory>granul
```

The program answers (in Portuguese):
```
< Granul.exe: Granulometria de correlacao para silicio poroso, versao 1.6>
_____________________________________________________________________________
Programas:
  CorrCirc  - Extremas das correlacoes com mascaras circulares
  CorrCirc2 - Extremas das correlacoes - raio inicial e final como parametros
  Classify  - Classifica automaticamente furos e quadrados
  Edit      - Edita manualmente furos/quadrados
  Relat     - Gera relatorio
.....................................................................
Erro: Numero de argumentos invalido
```

Indicating that program Granul has 4 subprograms inside. “Erro” does not indicate a real error, but that the parameters are missing.

Subprogram CorrCirc

This subprogram is the implementation of the correlation-based granulometry for circular objects.

To test the progra, copy test-a.pgm, test-b.pgm and test-c.pgm to a test directory. Execute in this directory:

```
c:\directory> granul corrcirc test-a.pgm test-a.hol 13 5 4
```

The parameters 13, 5 and 4 are respectively the quantity of circle sizes, the radius of the smallest circle and the number of circles per octave. Granul reads test-a.pgm and displays the following screen:

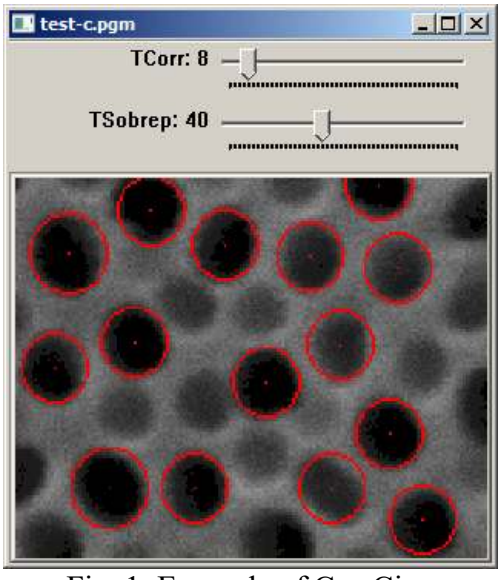


Fig. 1. Example of CorrCirc.

The trackbar “TCorr” controls the correlation threshold. Move it to left and right to select even the faint objects or only the clear objects.

The trackbar “TSobrep” controls the allowed superposition of the circles. Move it to left and right to allow selecting (or not) superposed circles.

Available commands are:
```
ESC=exit S=savehol H=hardcopy
```

Press ESC to exit the program. Do not click at X button to exit the program.

Press S to save test-a.hol (the objects detected using TCorr and TSobrep will be stored in this file). File test-a.hol is a text file and can be visualized in any text editor. For example, figure 1 above corresponds to:

```
num_radii=13
init_radius=5
radii_per_octave=4
tcorr=8
traio=10
tinfl=99
tquadrado=90
modorelat=r
n=15
0.144626 11.8921 89 136 f a
0.140341 14.1421 108 34 f a
0.13838 11.8921 23 76 f a
0.137639 11.8921 71 91 f a
0.13645 11.8921 57 43 f a
0.131933 11.8921 108 65 f a
0.128329 14.1421 26 19 f a
0.1153 11.8921 66 14 f a
0.112129 11.8921 27 107 f a
0.102628 11.8921 11 49 f a
0.100338 11.8921 119 148 f a
0.0974944 11.8921 31 139 f a
0.0911353 11.8921 58 118 f a
0.0849723 11.8921 2 132 f a
0.0827624 11.8921 108 115 f a
```

Fig. 2: test-a.hol text file.

This file can be used to generate the *granulometric curve* or *pattern spectrum*. Each row corresponds to a detected object. For example, in row

```
0.144626 11.8921 89 136 f a
```

the four numbers correspond to correlation, radius, row and column.

Press H to make a “hardcopy” of the image on the screen. The image that appears in the window will be saved as corrcirc.png.

Try processing test-b.pgm and test-c.pgm.

Subprograma classify

This and the subsequent subprograms are specifically designed to characterize porous silicon nanomaterial.

Subprogram classify classifies circles and squares semi-automatically based on "ad-hoc" heuristics. Run:

```
c:\directory> granul corrcirc test-b.pgm test-b.hol 13 3 4
```

Adjust TCorr and TSobrep. When satisfied, press "S" to save the file test-b.hol and "ESC" to exit. Then, run:

```
c:\directory>granul classify test-b.pgm test-b.hol
```

Adjust TRaio and TInfl to classify the detected objects in circle and square:

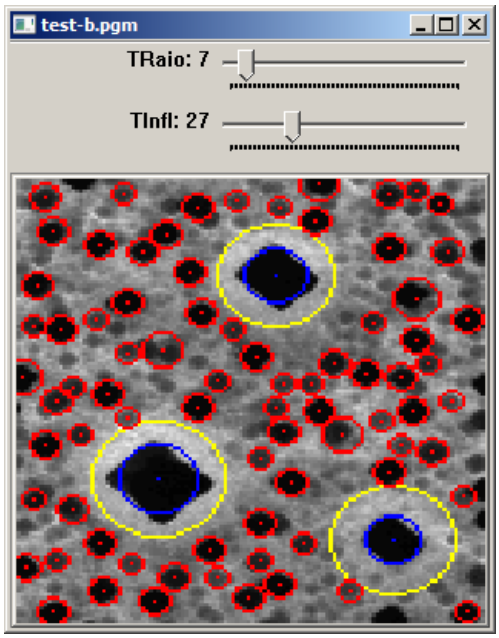


Fig. 3: Example of classify

For an object to be considered square, it must satisfy:

(radius>=TRaio) or (influence_zone>=TInfl)

Where radius is the radius of the object approximated as circle, and influence zone is the circular area where there are no other obhects.

Available commands are:
ESC=exit
S=save_hol_file
H=hardcopy

Do not forget to save the classification pressing S. Otherwise, the classification will be lost.

Subprogram edit

Subprogram edit allows inserting, deleting and changing the classification of the objects manually. It can be used to fix the errors commited by the previous subprograms. Run:

```
c:\directory>granul edit test-b.pgm test-b.hol
```

The window below will appear:

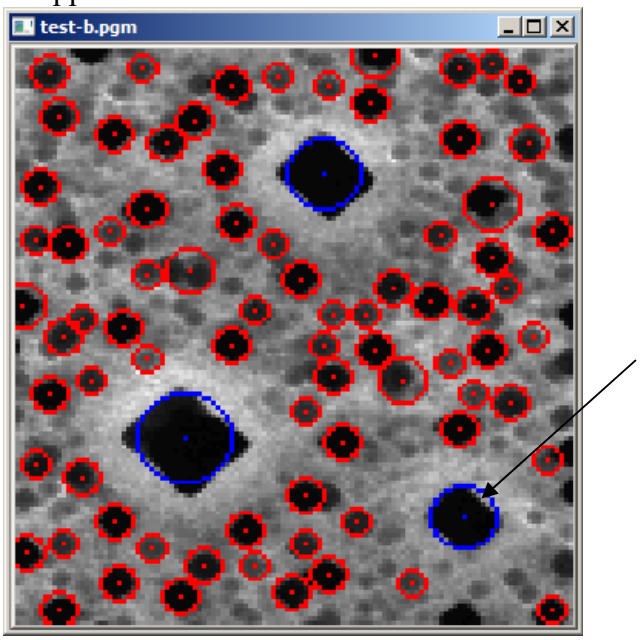
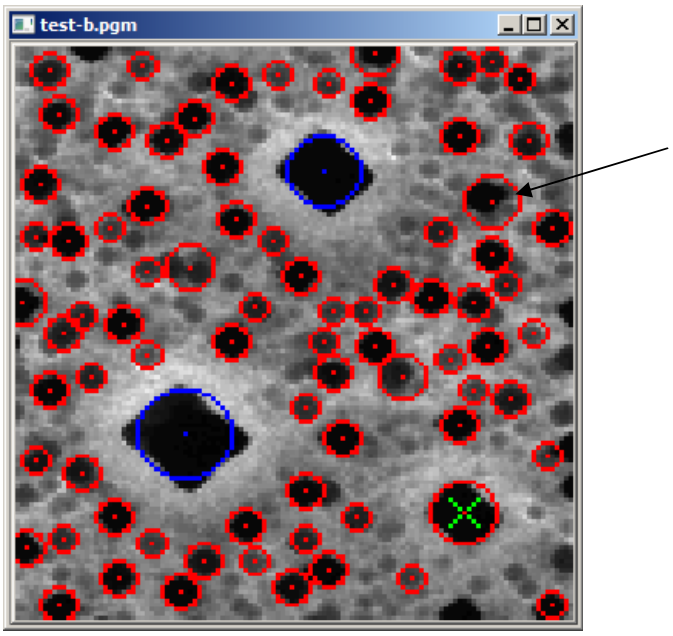


Fig. 4: Example of edit

Available commands are:
ESC=exit
S=save_hol_file
H=hardcopy
I=insert (used to insert manually new objects)
D=delete (used to manually delete objects)
F=furo/quad (change classification circle to square)
A=auto/manual (change classification type from auto to manual).

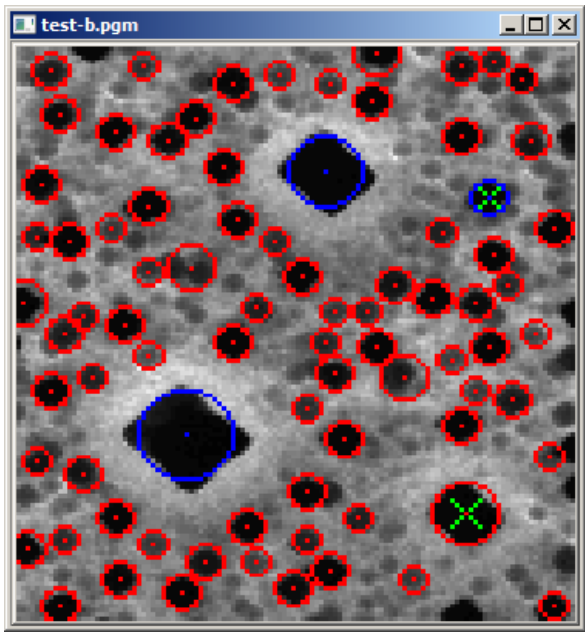
Let us change the classification of the object pointed by the arrow.

1) Press F (change classification).
2) Click once inside the object you want to change the classification.



A green X indicates that the object was edited manually. Let us delete the object pointed by arrow and insert a smaller object. To do it:

1) Press D (delete).
2) Click inside the object to be deleted.
3) Press I (insert).
4) Press mouse left button at the center of the new object, drag the mouse to the border of the circle and release it.



Note: It is possible to delete many objects at once, pressing mouse button, dragging the mouse and releasing the button. Everything inside the circle defined by press and release of the button will be deleted.

Do not forget to save the alterations pressing S.

Subprogram relat

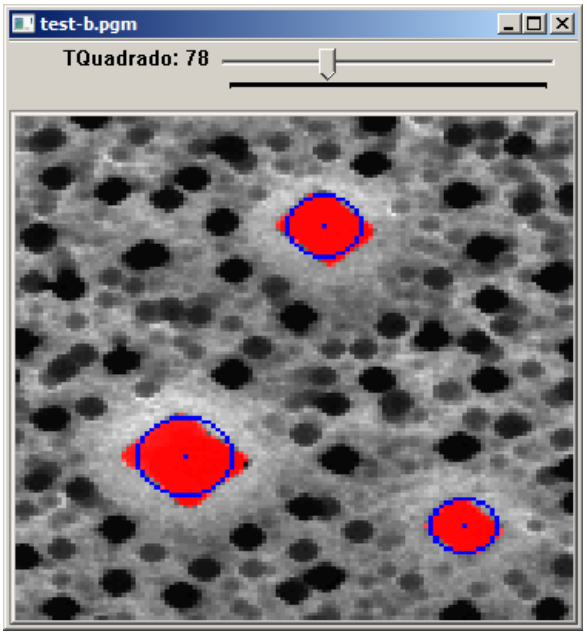
This subprogram computes the area of square objects and generates the report.

```
c:\lixo>granul relat test-b.pgm test-b.hol test-b.txt
```

This subprogram will read test-b.pgm and test-b.hol and will compute the area of square/rectangular pores.

Seed growing algorithm computes the area. Trackbar controls the termination condition of the seed growing. The seed growing can control the termination in two different modes:
1) ABS: Absolute grayscale.
2) REL: The difference between the grayscale of the pixel and the average grayscale of the pixels already classified (default).
The termination mode can be selected pressing A/R.

ESC=exit
S=save_hol_file
P=print_report
A=absolute mode
R=relative mode.



Press S to save the selected trackbar value.

Press P to print report test-b.txt. Below, an example of the report:

```
Area total da figura=15720 pixels.
Area total dos furos circulares=3270.46 pixels.
Area total dos furos quadrados=766 pixels.

Histograma dos furos circulares
  indice     raio     area  qtidade
       0     3.00    28.27       31
       1     3.57    39.99       25
       2     4.24    56.55       17
       3     5.05    79.97        4
       4     6.00   113.10        1
       5     7.14   159.94        0
       6     8.49   226.19        0
       7    10.09   319.89        0
       8    12.00   452.39        0
       9    14.27   639.78        0
      10    16.97   904.78        0
      11    20.18  1279.55        0
      12    24.00  1809.56        0

Histograma dos furos quadrados
  indice     raio     area  qtidade
       0     3.00    28.27        0
       1     3.57    39.99        0
       2     4.24    56.55        0
       3     5.05    79.97        0
       4     6.00   113.10        0
       5     7.14   159.94        1
       6     8.49   226.19        1
       7    10.09   319.89        1
       8    12.00   452.39        0
       9    14.27   639.78        0
      10    16.97   904.78        0
      11    20.18  1279.55        0
      12    24.00  1809.56        0

Histograma das zonas de infl. dos f. quad.
  indice     raio     area  atidade
       0     3.00    28.27        0
       1     3.57    39.99        0
       2     4.24    56.55        0
       3     5.05    79.97        0
       4     6.00   113.10        0
       5     7.14   159.94        0
       6     8.49   226.19        0
       7    10.09   319.89        0
       8    12.00   452.39        0
       9    14.27   639.78        1
      10    16.97   904.78        2
```

Unfortunately, the report is in Portuguese. From this report, granulometric curves can be plotted using some commercial program like Excel ou Matlab.

Re-compilation of Granul

To compile granul.cpp, you have to install Proeikon library (www.lps.usp.br/~hae/software). Then, you can compile it using:

c:\directory>cpv granul