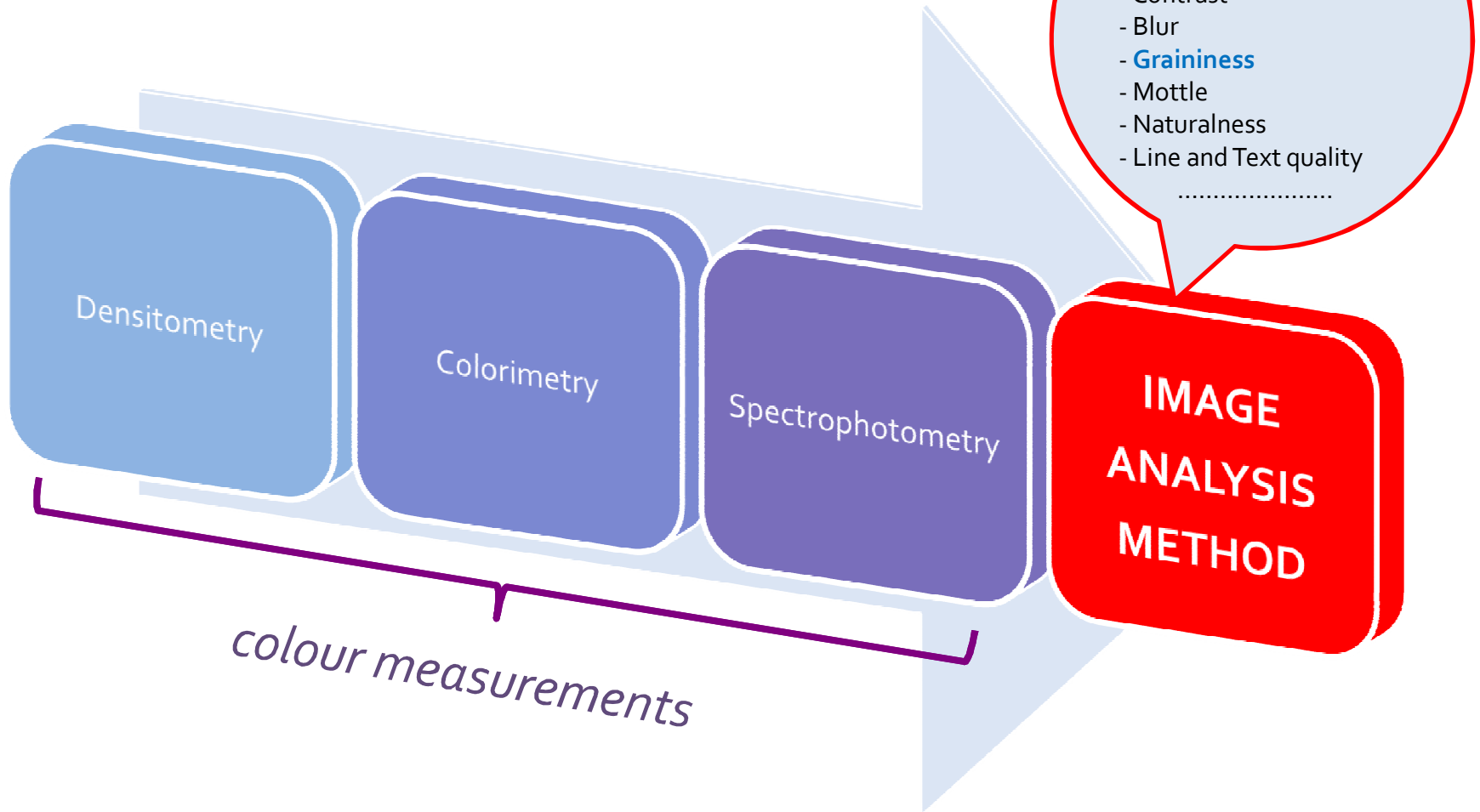# Different methods for quantification of micro-uniformity

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Print QUALITY control?

Plenty of other parameters:
- Sharpness
- Contrast
- Blur
- **Graininess**
- Mottle
- Naturalness
- Line and Text quality
  ....

Densitometry

Colorimetry

Spectrophotometry

IMAGE ANALYSIS METHOD

colour measurements

ISO 13660:2001 + QEA, Inc.

- ISO 13660 is the first international standard to incorporate a wide range of print quality attributes.

Required elements on test form:
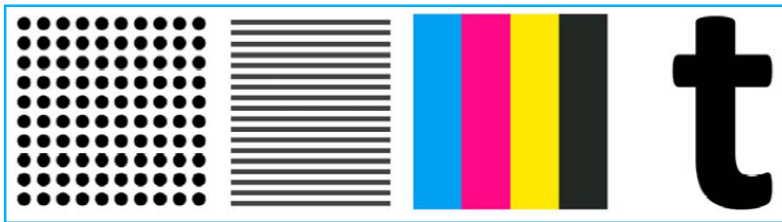
Commercially available PQ analysis system:

Character and Line
1. Blurriness
2. Raggedness
3. Line width
4. Darkness, character
5. Contrast
6. Fill
7. Extraneous marks, character field
8. Background haze, character field

Large Area
1. Darkness, large area
2. Background Haze
3. Graininess
4. Mottle
5. Extraneous marks, background
6. Voids

ISO 15311

- *Graphic Technology - Requirements for printed matter utilizing digital printing technologies for the commercial and industrial production.*

Structure of standard:

- Part 1: Parameters and measurement methods

- Part 2: Commercial production printing

- Part 3: Large Format Printing (Signage)

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Graininess

- small-scale (micro) non-uniformity

- ISO 13660:2001 defines it as, "*Aperiodic fluctuations of density at a spatial frequency greater than 0.4 cycles per millimeter in all directions.*"

- **Graininess** : subjective perception of a mottled random pattern apparent to a viewer who sees small local-density variations in an area of overall uniform density. *(Kodak Print Grain Index)*

Graininess measurements:

- Region of interest (ROI) should be at least 161mm², with smallest dimesions 12.7mm
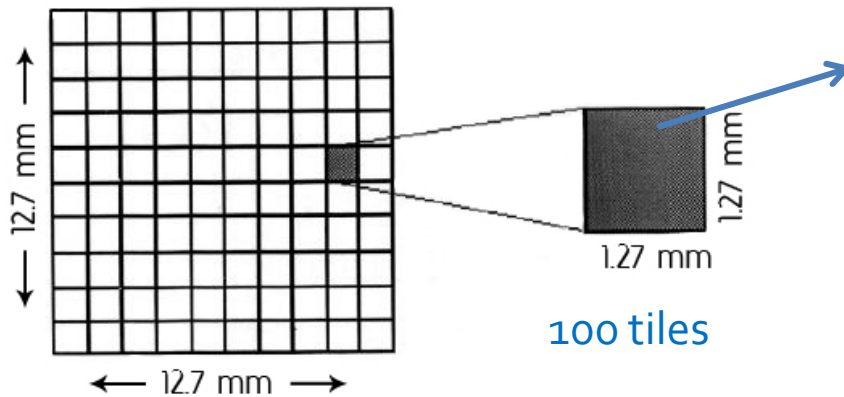
ROI

12.7 mm

12.7 mm

1.27 mm

1.27 mm

100 tiles

1. Within each tile, make 900 evenly spaced measurements of optical density

2. m_i is the average of these measurements

3. σ_i is the standard deviation of the measurements

Graininess is calculated:

$$GI = \frac{\sqrt{\sum_{i=1}^{n} \sigma_i^2}}{n}$$

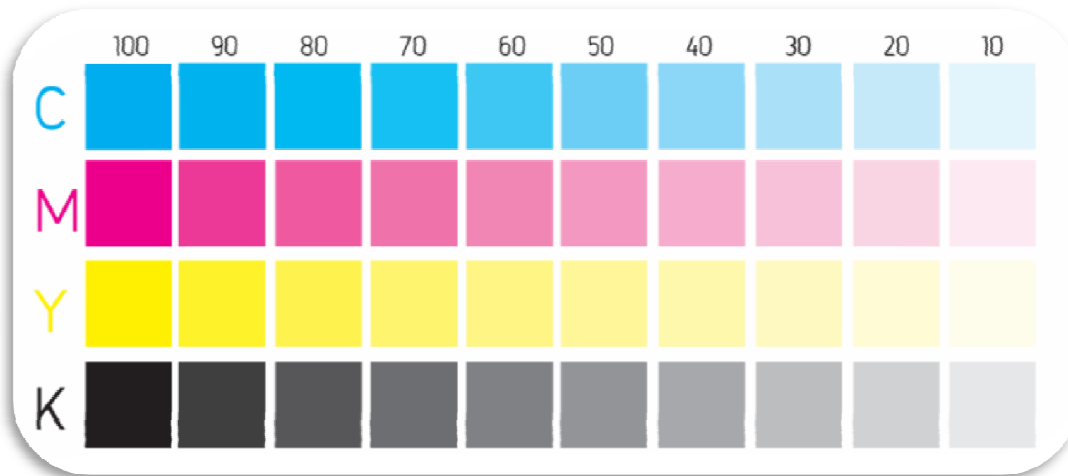n is the total number of tiles

The **goal** of this paper ….

..... to find method for evaluation of graininess that is in correlation with method defined by standard ISO 13660:2001

Materials and method

- two different papers: coated and uncoated

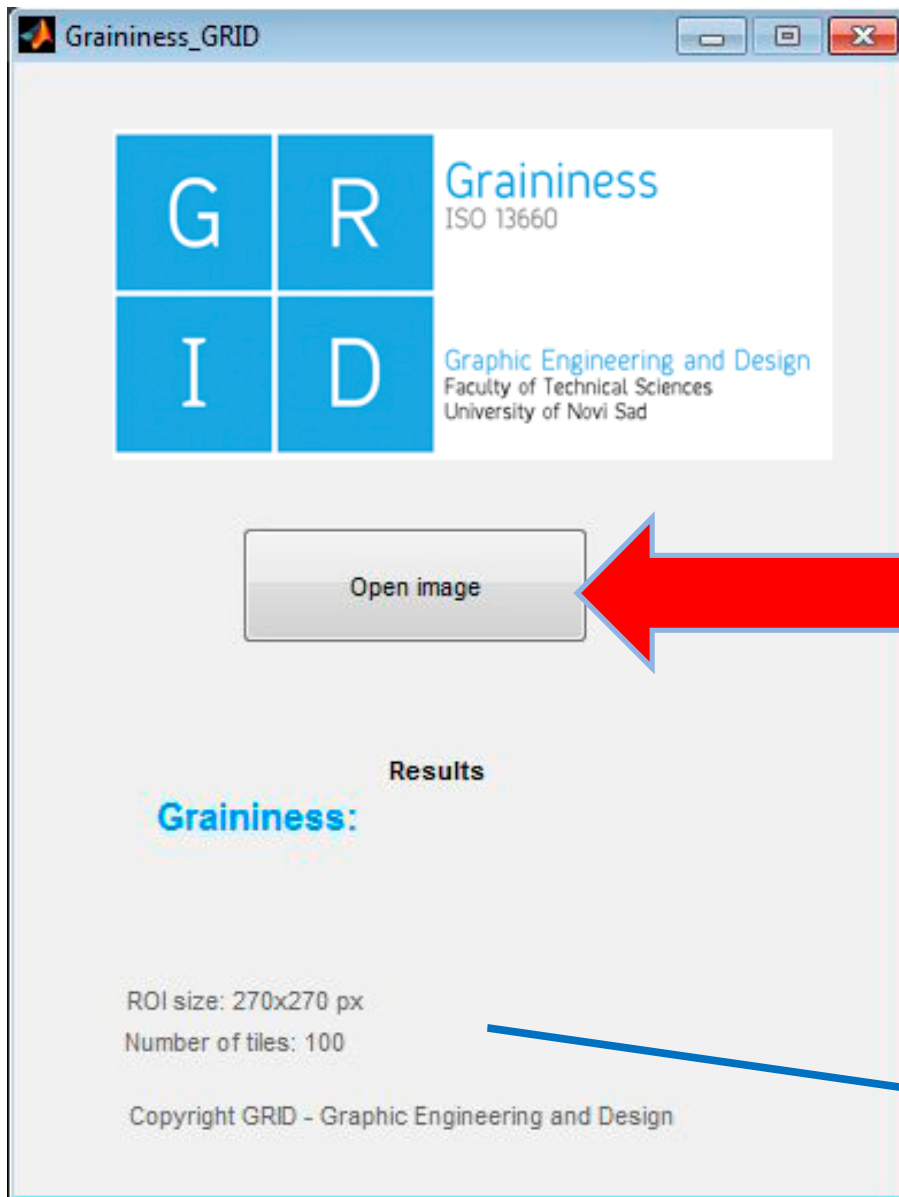- Test chart: patches 12x12mm

- Printing machine: Xerox DocuColour 252, electrophotography

Materials and method

- Micro-uniformity (graininess) was evaluated with two methods:

  1. commercially available, measurement device **Personal IAS**

  2. GUI (plug-in) for MATLAB software, developed on our Department > **Graininess_GRID**

- Digitalization of prints :
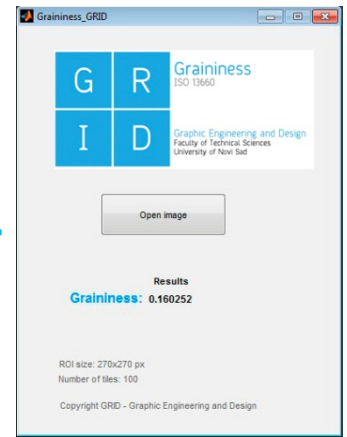
CanonScan5600F

In order to calculate the graininess value, it is necessary to open the image!

- Information about the image
- Copyright

After selecting the image, it takes **several seconds** to print results!

Graininess_GRID

- Plug-in for MATLAB software

- It works on the assessment of grayscale values of neighbouring pixels

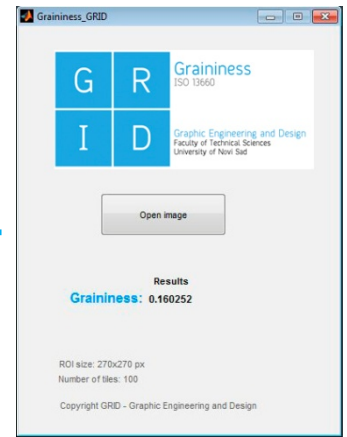- Samples were scanned at two different resolutions (600 and 1200spi), *tif* file

ROI (600spi) :
270x270px

ROI (1200) :
540X540px

12 X 12 mm

Graininess_GRID

Button: **Open image** `openimage=uigetfile({'*.tif'},'SelectFile');`

```
% get image data
im=imread(openimage);
% get XYZ values
```

1.: `im_XYZ=rgb2xyz(im);`

```
% get L*, a*, b*
im_Lab=xyz2lab(im_XYZ);
% separate the L* channel,
get grayscale data
L_star=im_Lab(:,:,1);
```
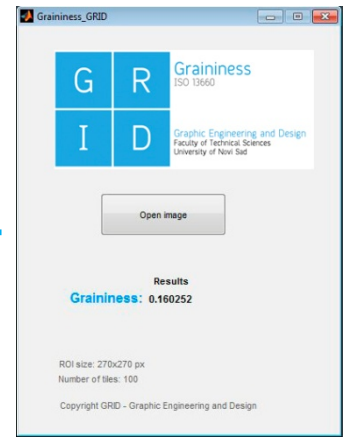
2.:

```
% get grayscale data,
using built-in function


imGray=rgb2gray(im);
```
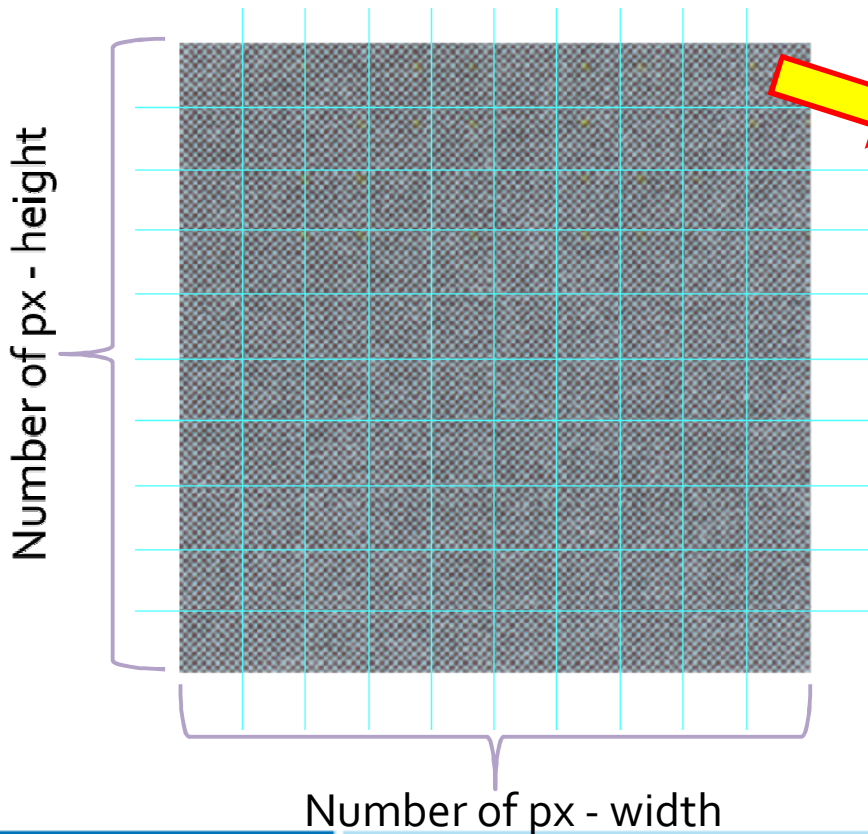
Graininess_GRID

```
%In order to crop the image into tiles, we need
information about number of pixels ih height and
width:
```

```
[height, width, n_channel] = size(L_star);
```


Number of px - height

Number of px - width

```
%One tile is cropped:
crop_width = round(width/10);
crop_height = round(height/10);

origin_x = (width - 1) *
crop_width + 1;
origin_y = (height - 1) *
crop_height + 1;
cropped_tile=
imcrop(original_image, [origin_x
origin_y crop_width-1
crop_height-1]);
```
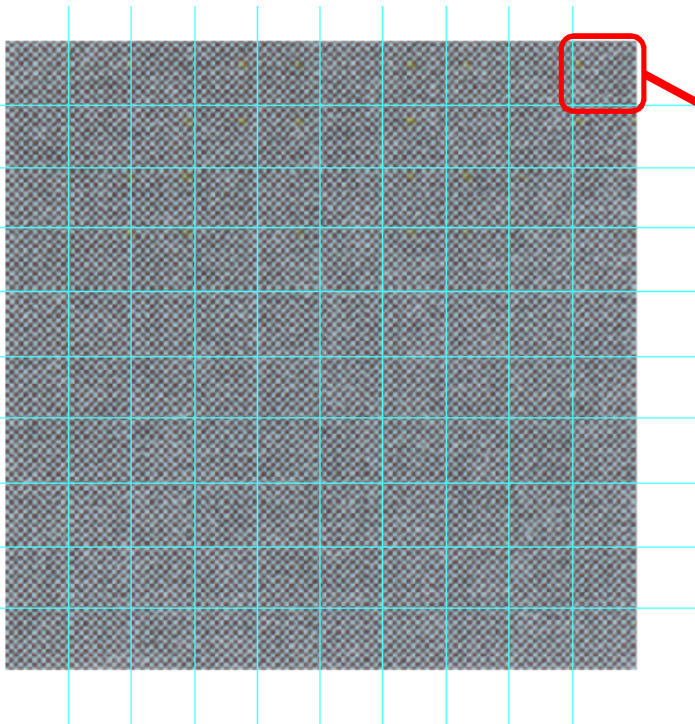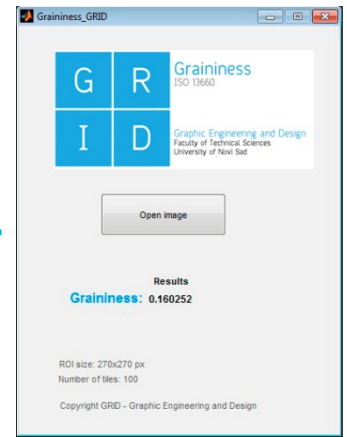
Graininess_GRID

ISO 13660 defines that:
1. Within each tile, make 900 evenly spaced measurements of optical density
2. m_i is the average of these measurements
3. σ_i is the standard deviation of the measurements

Instead of the optical density, which is measured within each tile *i*, we used the
pixel intensity value!

```
%Within each tile, every px has its
intensity value. A (width, height) is
matrix in which every element is standard
deviation of px intensity values

A(width,height) = std2(cropped_tile);
```
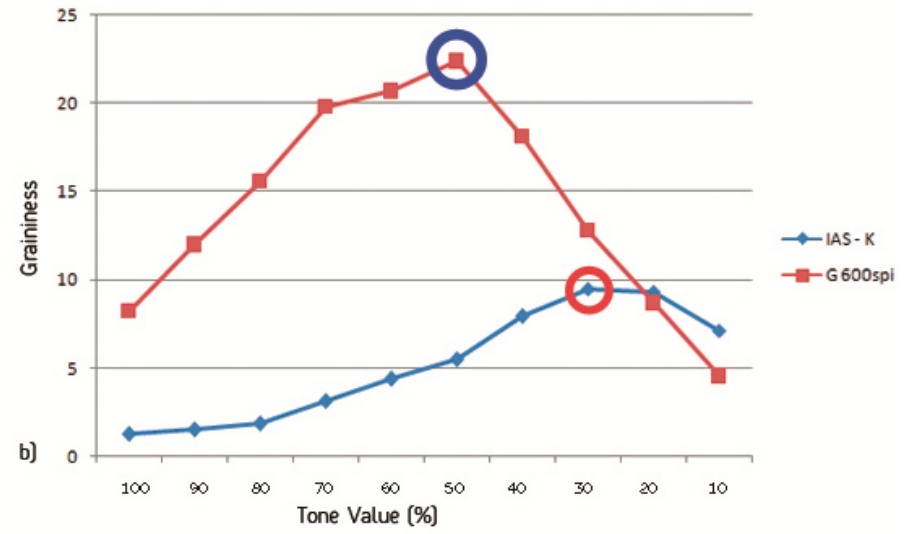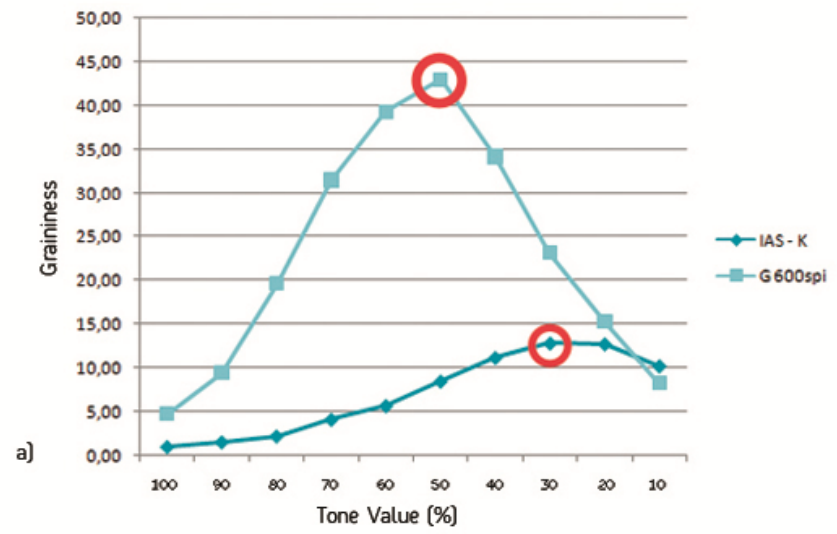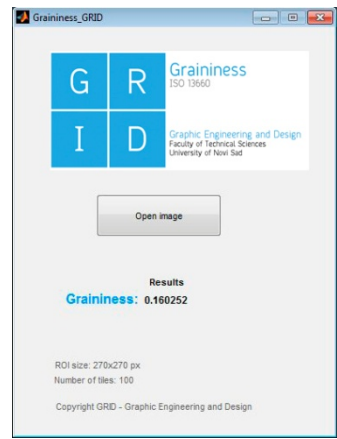
$$GI = \frac{\sqrt{\sum_{i=1}^{n} \sigma_i^2}}{n}$$

```
B=A.^2;
C=sqrt(sum(B(:)));
D=C/100;
```

n=100 (number of tiles)

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Results for measuring black colour on coated (a) and uncoated (b) paper with commercially available solution – device Personal IAS and our plug-in using scanning resolution of 6oospi (L*channel).

CONCLUSION

- Being able to quantify graininess is very helpful in print quality assessment.

- In this paper we presented plug-in for measuring graininess in MATLAB software which works on the assessment of grayscale values of neighbouring pixels.

- Unfortunately, results obtained with plug-in are not in good correlation with results obtained using measuring device.

CONCLUSION

- To find the cause of this, it is necessary to change something in the development of plug-in.

- The sampling method…we can try with another scanner or some CCD camera…

- Or to change method of generation of grayscale data

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