Evaluation of distinctness of image of enhanced printed samples

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Geometric attributes of printed samples

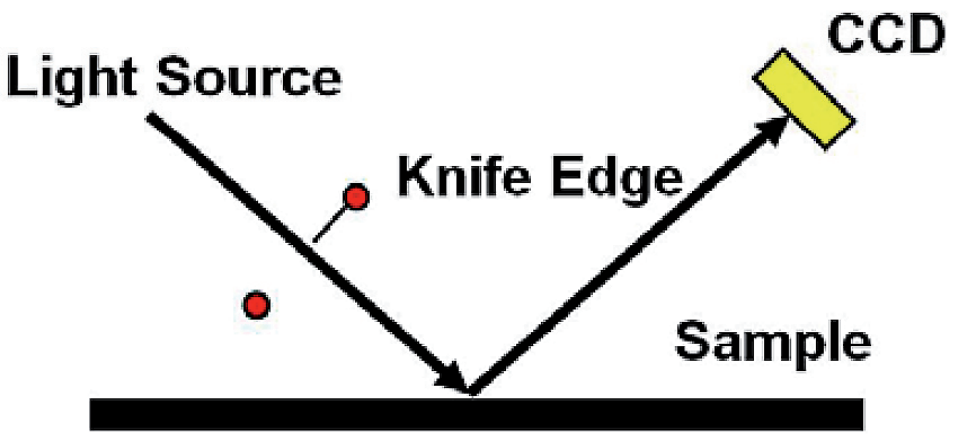
- Perception of geometric attributes does not have the tridimensional limitation as colour perception
- Different types of gloss (specular, sheen, luster, absence of bloom, distinctness of image, surface-uniformity gloss) and transparency
- Specular gloss is usually used to describe surface properties of printed samples
- Fails to describe how well surface reflect image being project on it

Distinctness of image (DOI)

- Defines the deviation of the spread of light reflected at the specular angle
- Sensitive to even subtle scattering effects

Measuring DOI

- ASTM D5767-95(1999) - measuring light reflected at a specular angle and at the angle slightly of the specular
- Projecting the light through a small slit on the specimen surface and measuring its reflected image intensity through a sliding combed shutter
- At third method the light through a pattern is projected on the specimen surface and its reflected image intensity is measured directly to provide a value of image clarity

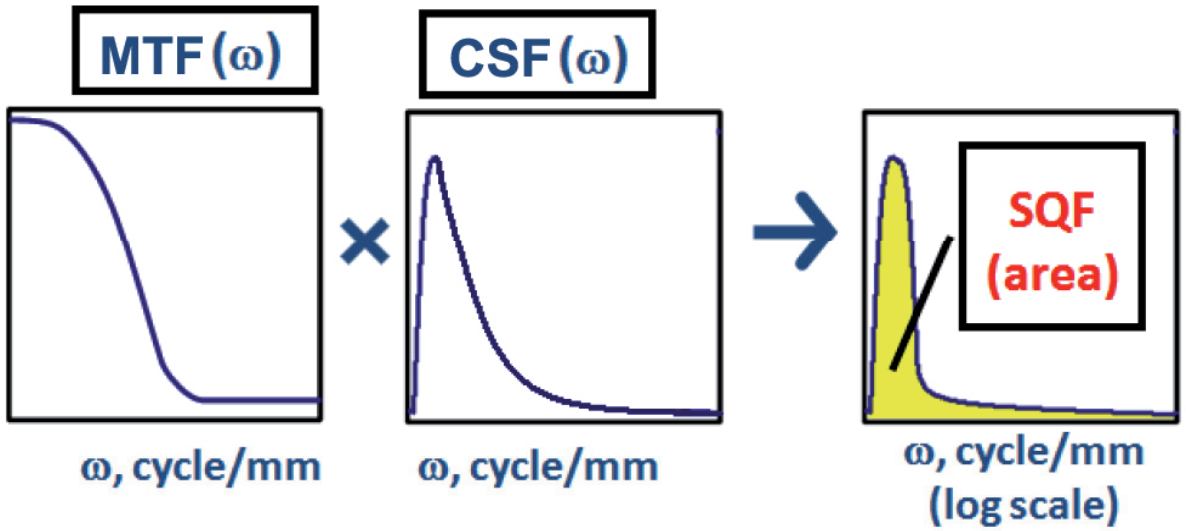


Calculating DOI

- Obtaining the reflectance profile (Edge spread function - ESF) from the digitalized image
- Taking the first derivative of the ESF to calculate line spread function (LSF)
- Aplying a Fourier transform to LSF in order to obtain Modulation transfer function – MTF
- MTF describes relative contrast at a given spatial frequency (output contrast/input contrast)
- Best indicator of line sharpness are spatial frequencies where MTF is 50% of its low frequency value (MTF50) or its peak values (MTF50P)

Calculating DOI

- Incorporating human sensitivity into calculation in order to filter out the noise
- Visual contrast sensitivity function – CSF
- Subjective quality factor - SQF



Aim of the work

- The aim of this study was to test whether the method for measuring DOI, based on analyzing image reflected from the surface, can be used to predict distinctness of image for offset printed samples enhanced with different types and amounts of coating
- It was assumed that DOI will be improved if the paper is enhanced with glossy coatings, while lower DOI values are expected if matte coating is applied

Method

1. Preparing the samples

- Test image (10x20 cm rectangle,100% black) was printed on glossy 130g/m^2 paper (defined as Type 1 in ISO 12647-2:2004)
- Machine: KBA Rapida 105 (4 colour offset printing machine equipped with an additional coating tower with closed chamber doctor blade system)
- Inks: Sun Chemical World and HyBrite series (complying with the ISO 2846-1:2006)
- Printing: in accordance to ISO 12647-2:2004

Method

1. Preparing the samples

- Coating: - conventional inks with aqueous glossy Prestofix Hochglanzlack H6055/55 and aqueous matte coating Prestofix Mattlack H260/55 (60 l/cm and 90 l/cm)

  - hybrid inks with UV glossy coating VP 10532 from VEGRA (60 l/cm and 90 l/cm)

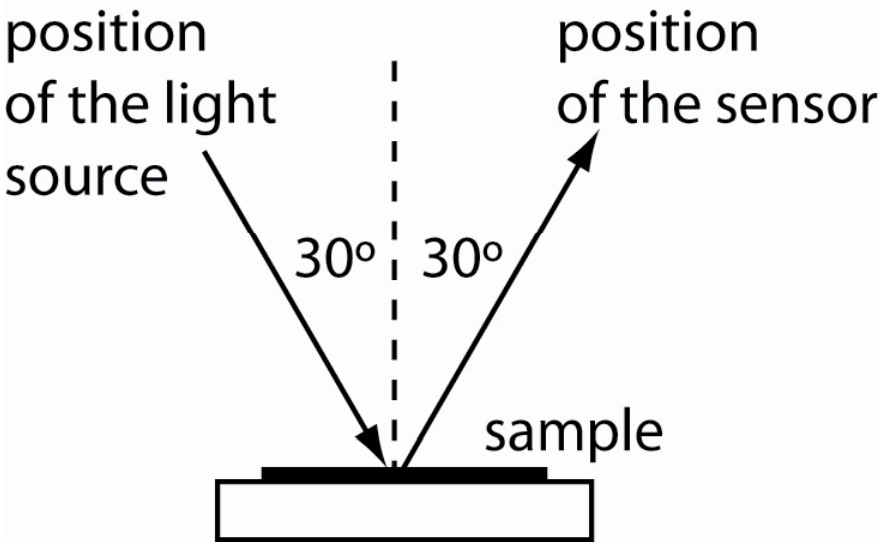
- Drying: - prints with conventional inks were dried with the machine IR drying system at the settings specified by the press manufacturer

  - prints with hybrid inks by the UV lamps installed on the machine (factory settings)

Method

2. Obtaining the images

- Light source: USB lamp
- Sensor: USB microscope Veho VMS-001 (CMOS sensor) operating without LED lamps
- Angle: 30°



Method

3. Calculating DOI metrics

- Software: Imatest 3.1 (option: SFR module)
- Region of interest: 300 x 500 pixels at 300 ppi (manually adjusted)
- Parameters recorded were: MTF50, MTF30 and SQF
- CSF obtained as:

  $CSF(f) = 0.114\ f \exp(0.1254\ f)$

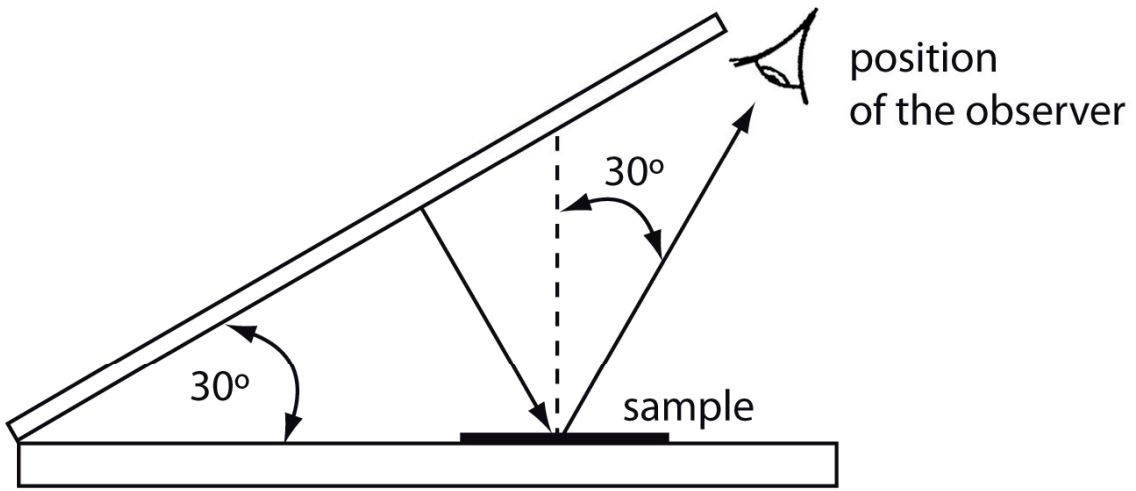
- SQF calculated as:

  $SQF = K \int CSF(f)\ MTF(f)\ d(\log f)$

Method

4. Perceptual evaluation

- Assesors: 10 observers, with normal to corrected vision
- Light source: laptop computer (LED light source)
- Projected images: black/white vertical lines with 50% duty cycle and various line spacing ranging from 4-40 px
- Setting >



Results

- Objective values and subjective rankings for samples printed with conventional inks

Type and amount of the coating	MTF30 (cycles/mm)	MTF50 (cycles/mm)	SQF	Subjective ranking
None	0.242	0.304	6.57	8.25
Aqueous matte (60 l/cm)	0.227	0.264	9.26	6
Aqueous matte (90 l/cm)	0.282	0.457	8.77	7.3
Aqueous glossy (60 l/cm)	0.294	0.348	11.95	9.6
Aqueous glossy (90 l/cm)	0.205	0.327	9.86	9.25

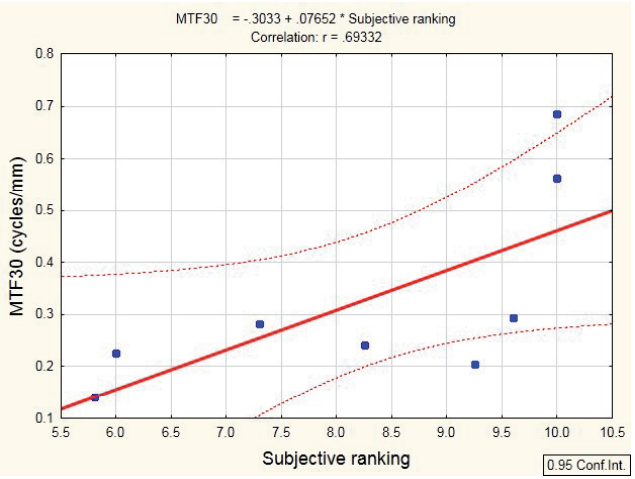
Results

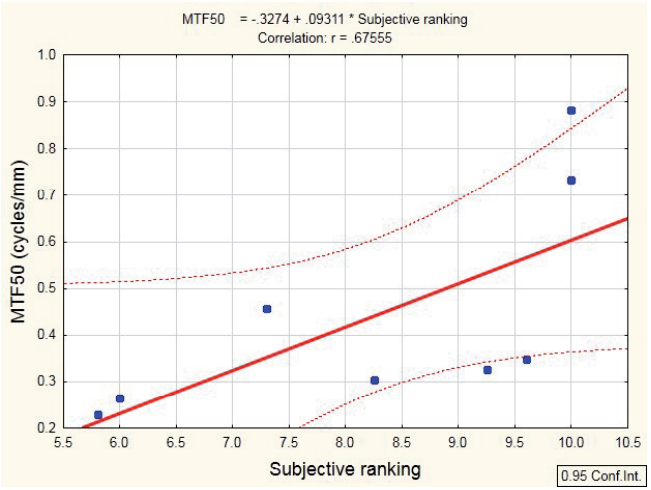
- Objective values and subjective rankings for samples printed with hybrid inks

Type and amount of the coating	MTF30 (cycles/mm)	MTF50 (cycles/mm)	SQF	Subjective ranking
None	0.14	0.229	7.74	5.8
UV (60 l/cm)	0.563	0.734	16.22	10
UV (90 l/cm)	0.686	0.882	11.34	10

Results

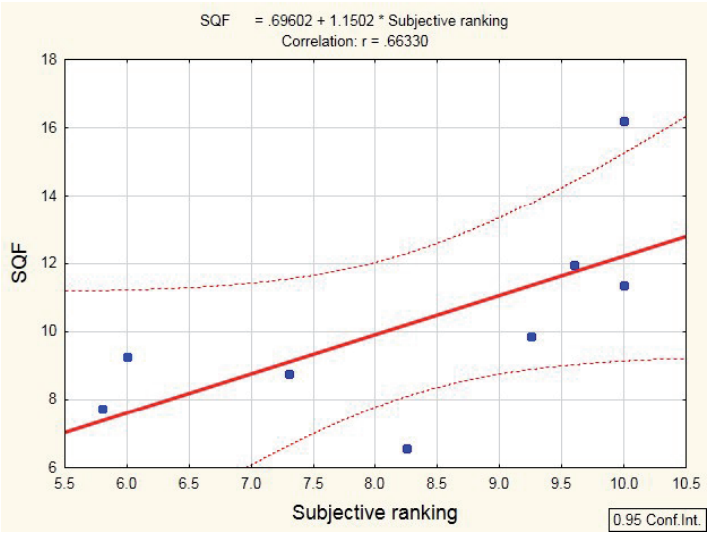
- No correlation between MTF50 or MTF30 and subjective rankings for samples printed with conventional inks
- For hybrid inks high correlation exists between these values (r-0.977 for MTF50 and 0.976 for MTF30)
- If the matte samples are omitted from the calculation correlation is improved even for the first set of samples (r-0.97 for MTF50)





Results

- Weak correlations between SQF values and subjective ratings for samples printed with conventional inks (r- 0.413)
- If the values for matte samples were omitted correlation was high (r-0.989)
- Moderate correlation between SQF values and subjective ratings for samples printed with hybrid inks (r-0.819)
- Overal: low correlation (r-0.663)



Conclusion

- High degree of correlation between all DOI metrics and subjective evaluations was obtained for samples enhanced with glossy coatings.
- Low overall correlation can be explained with the limitation of a sensor used for detecting and using only one measuring angle.