



DEPARTMENT OF IMAGE PROCESSING

INSTITUTE OF INFORMATION THEORY AND AUTOMATION

Místo lupy počítač jak se dostat za hranice lidských možností

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Akademia věd České republiky

zitova @ utia.cas.cz, zoi.utia.cas.cz

Naděje a rizika digitálního věku AV21





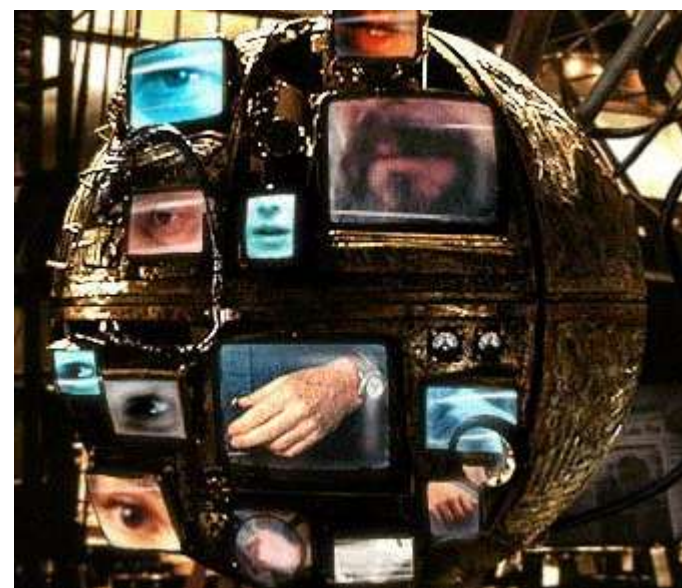
Místo lupy počítač jak se dostat za hranice lidských možností





- **880 miliard fotografií**
- **každou minutu 300 hod videa na Youtube**

Zdroj: 2014

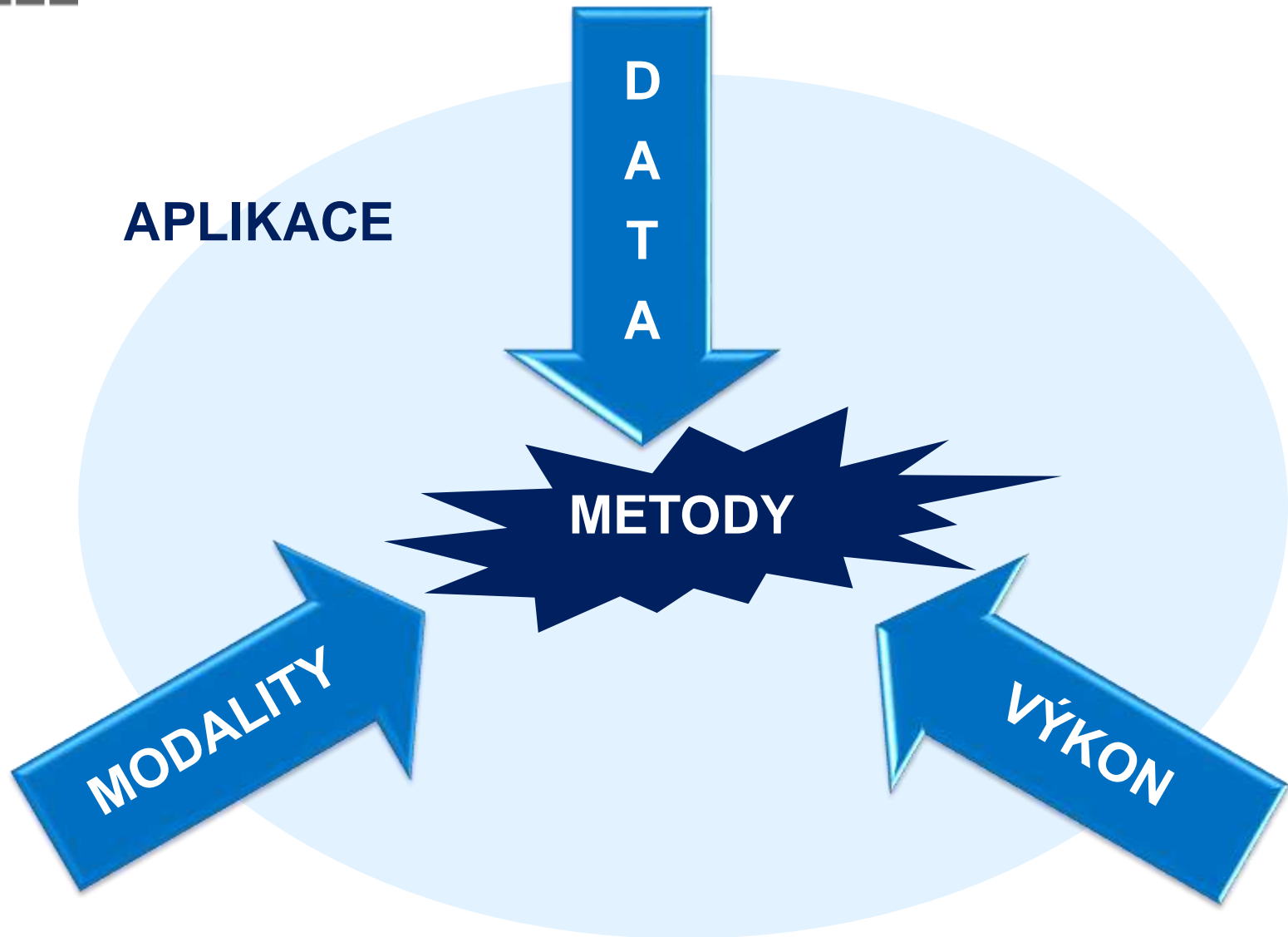


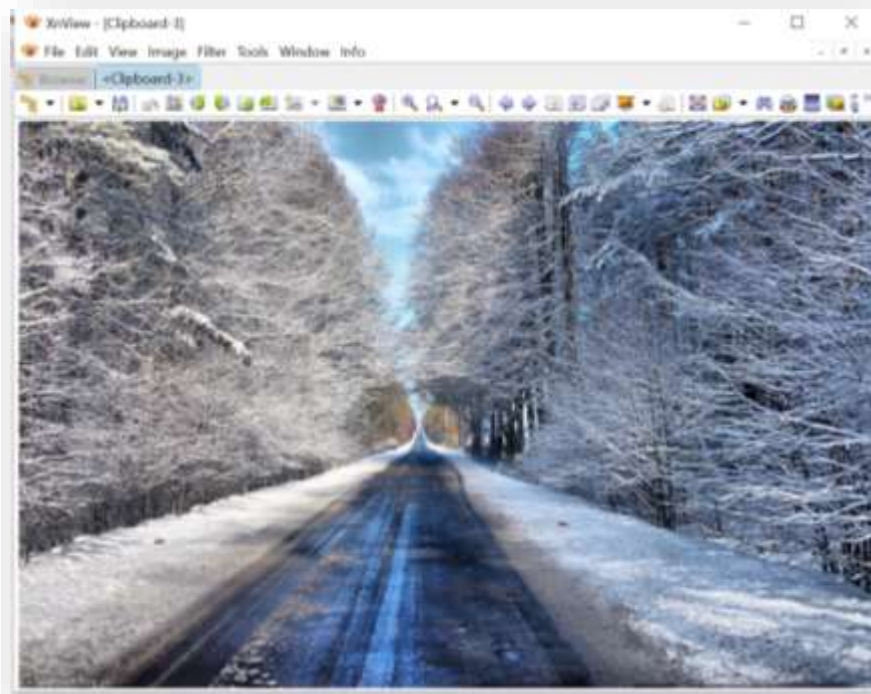


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... Photoshop, gimp, xnview



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Rozpoznávání objektů ve scéně

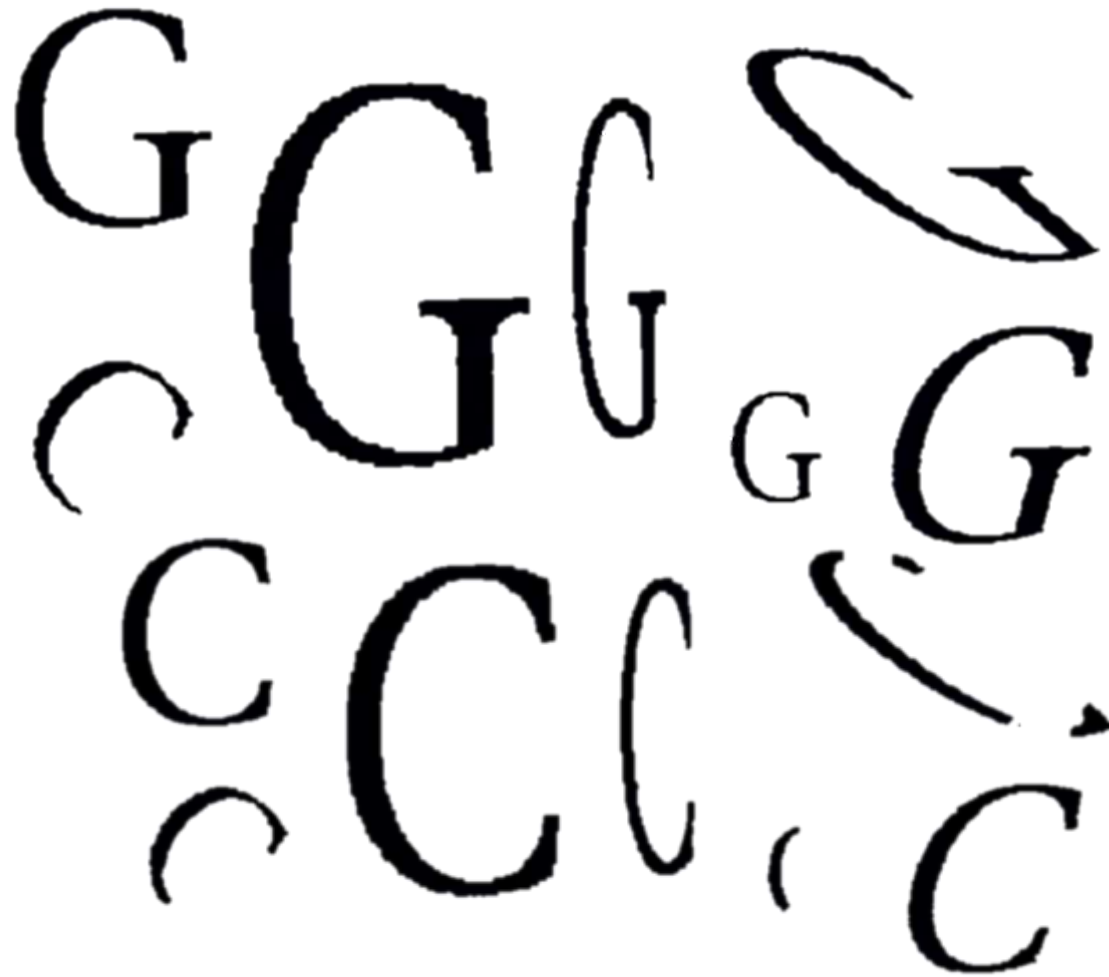


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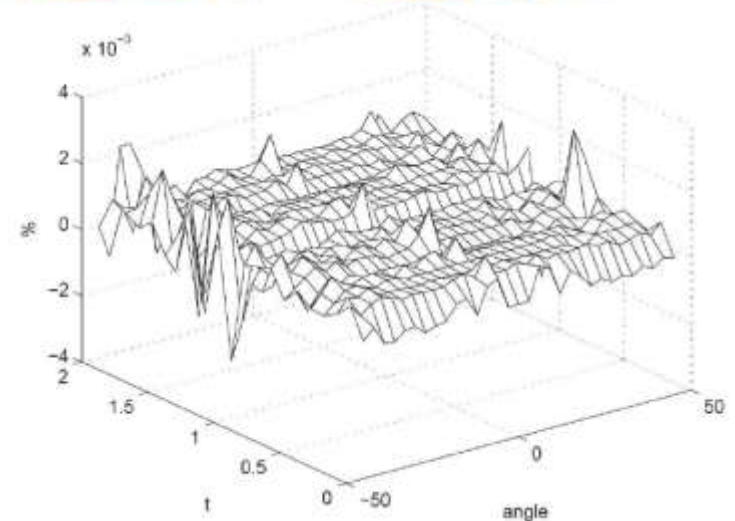
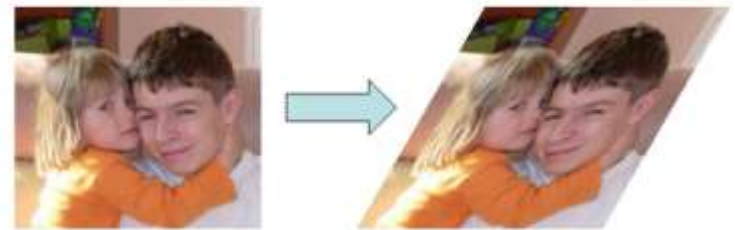


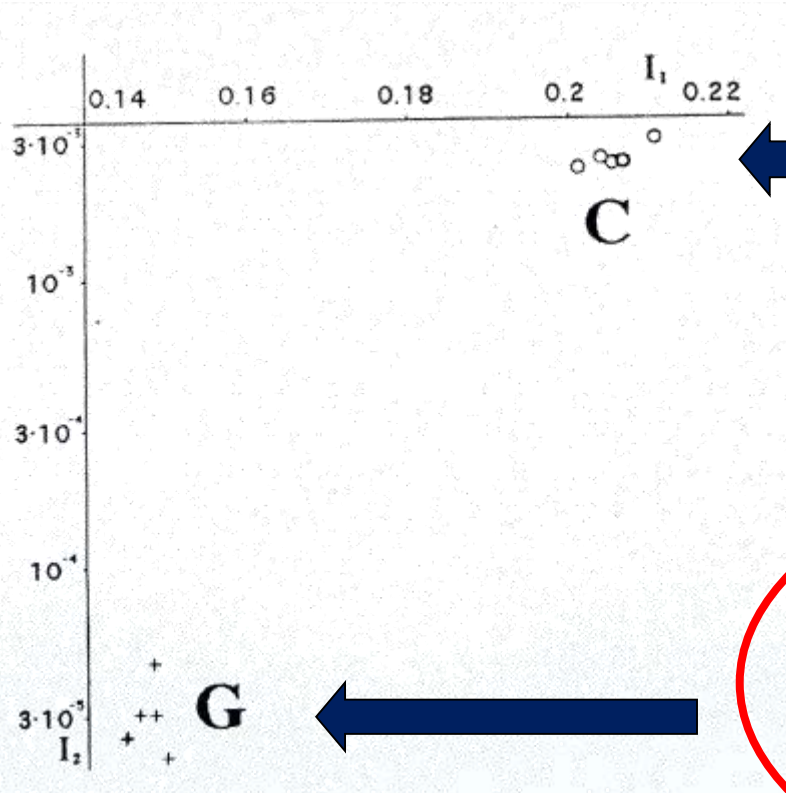


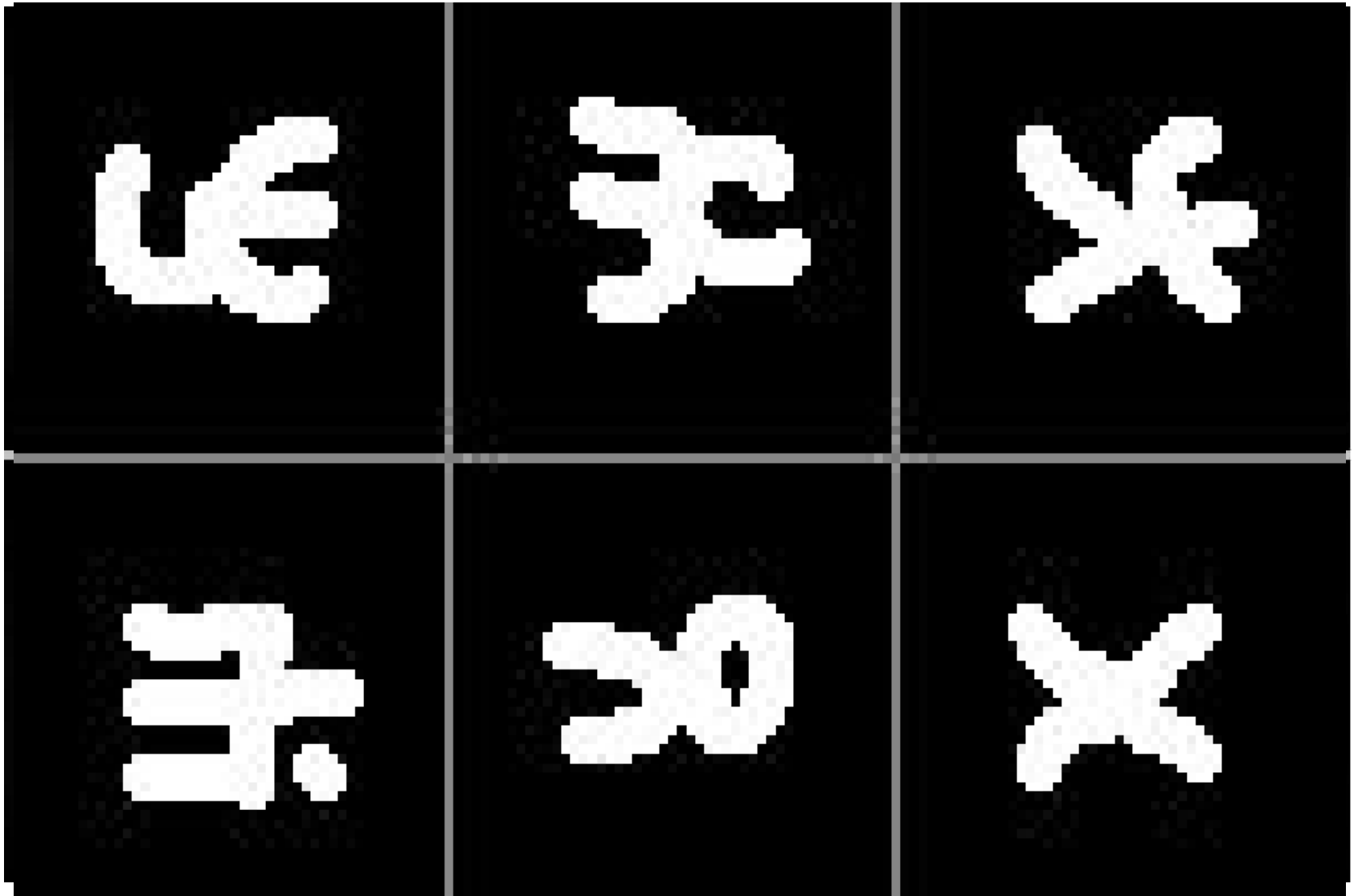
C \equiv (výška, barva, plocha ...)

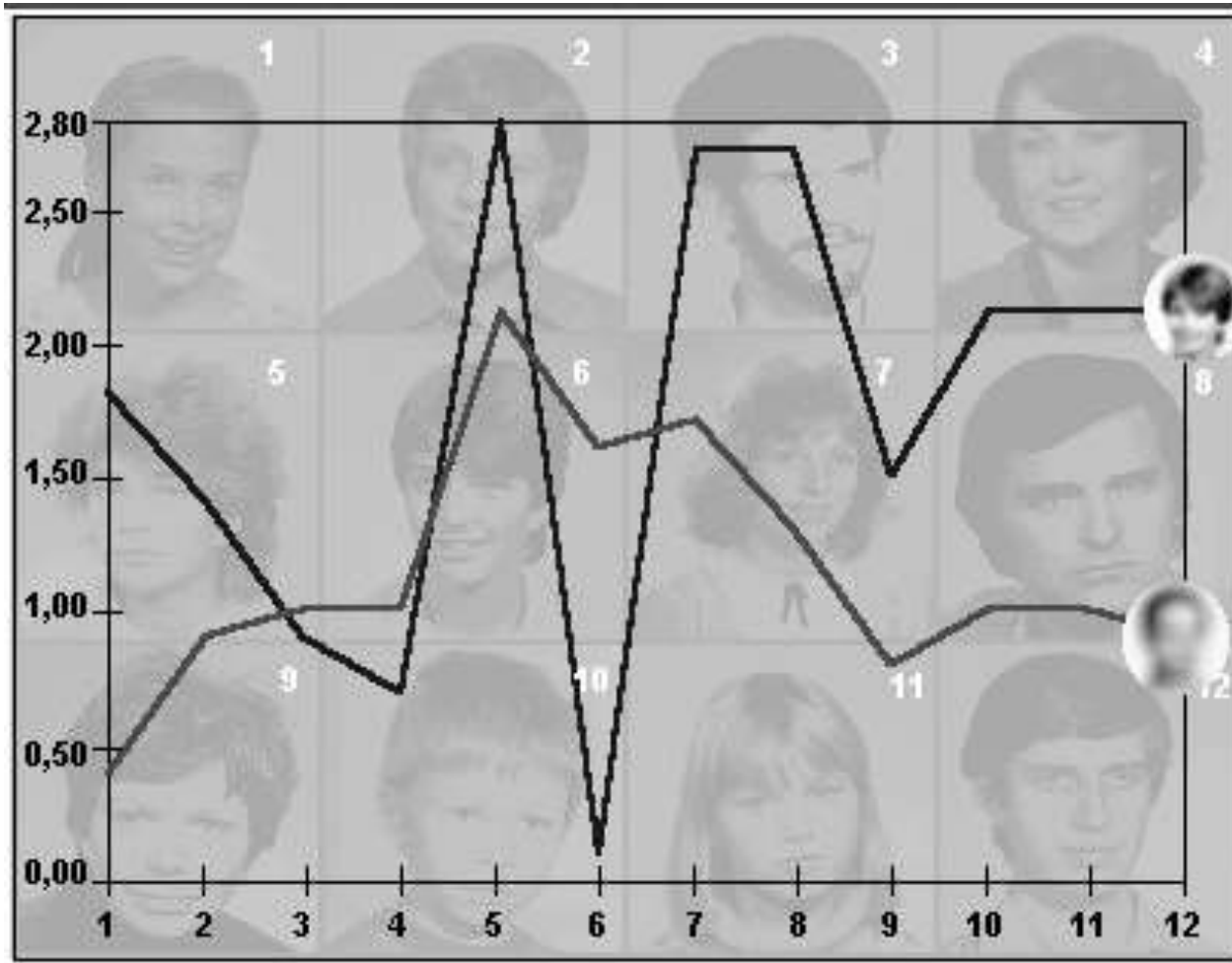
$$m_{pq}^{(f)} = \int_{R^2} x^p y^q f(x, y) dx dy$$

$$I_1 = (\mu_{20}\mu_{02} - \mu_{11}^2) / \mu_{00}^4$$











$$K(p, q)^{(f)} = c_{pq}^{(f)} - \frac{1}{c_{00}^{(f)}} \sum_{n=0}^p \sum_{\substack{m=0 \\ 0 < n+m < p+q}}^q \binom{p}{n} \binom{q}{m} K(p-n, q-m)^{(f)} \cdot c_{nm}^{(f)}$$

PSF centrosymetrické, $(p + q)$ liché



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Forenzní analýzy



1. Analýza zdrojového zařízení



2. Analýza dodatečných změn v digitálním obraze

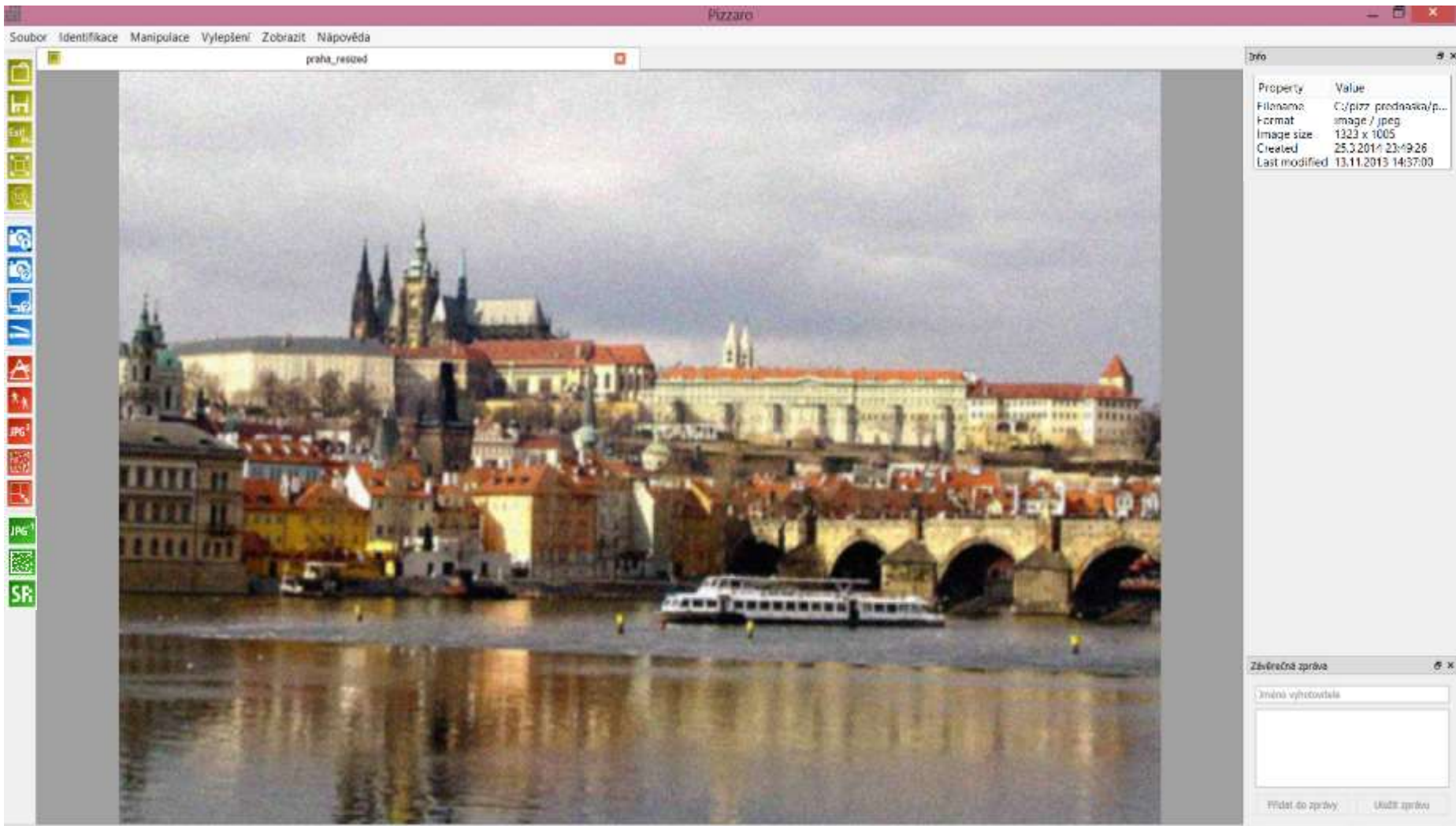


3. Rekonstrukce obrazového materiálu





PIZZARO forensic software tool





Identifikace zařízení

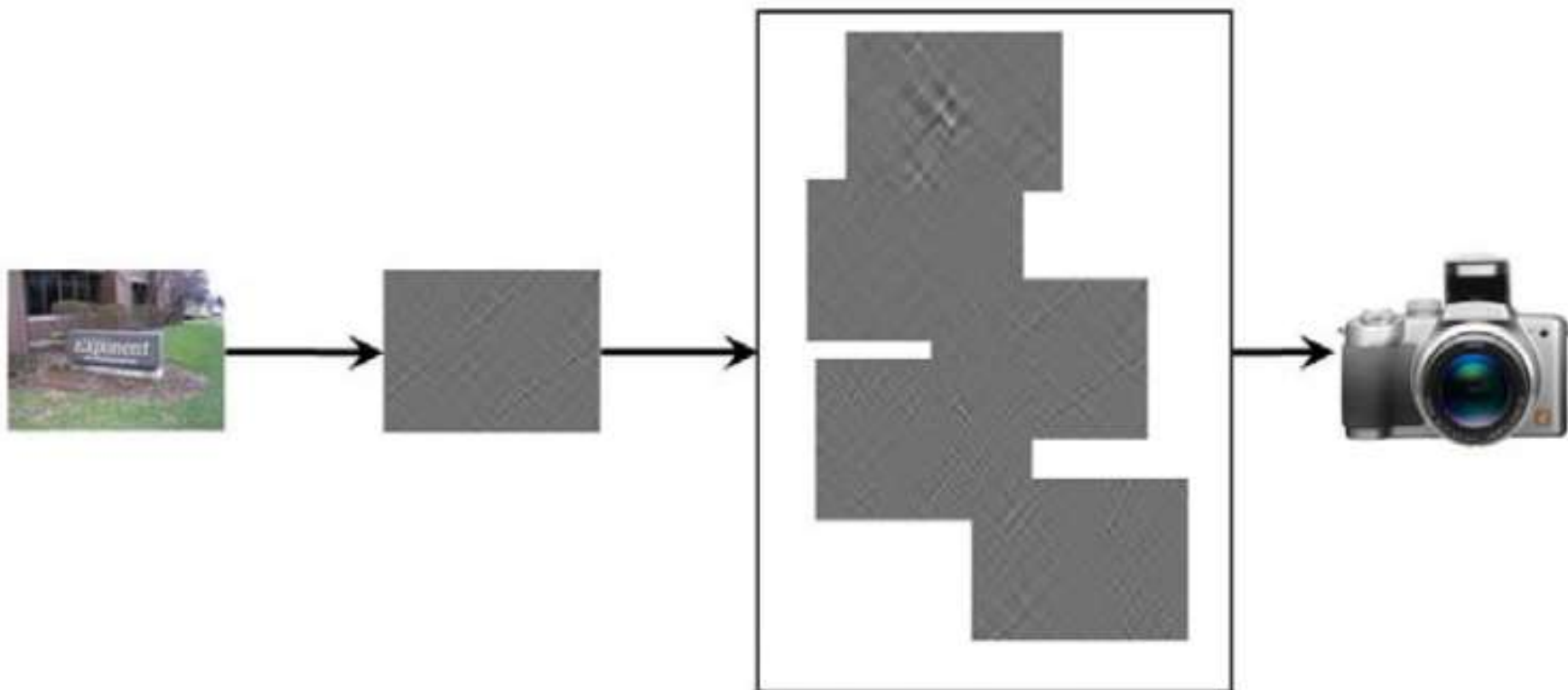
photo response non uniformity noise (PRNU)





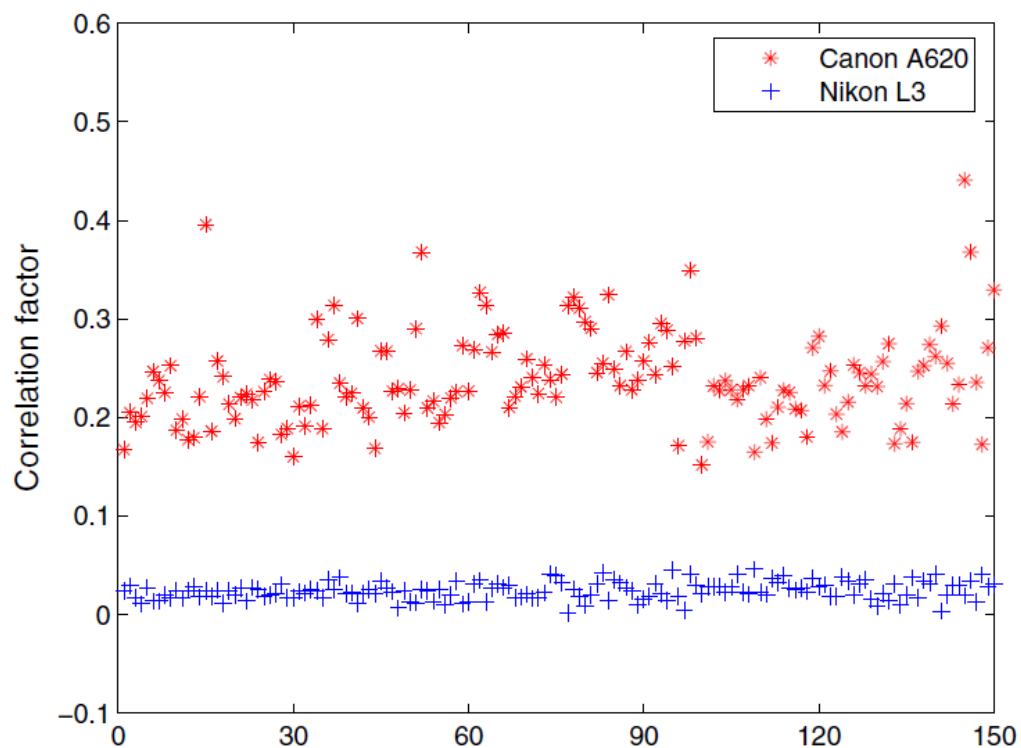
Identifikace zařízení

photo response non uniformity noise (PRNU)





Identifikace zařízení



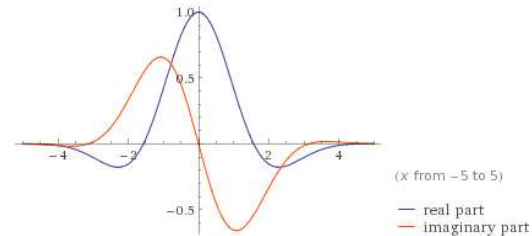


Identifikace třídy

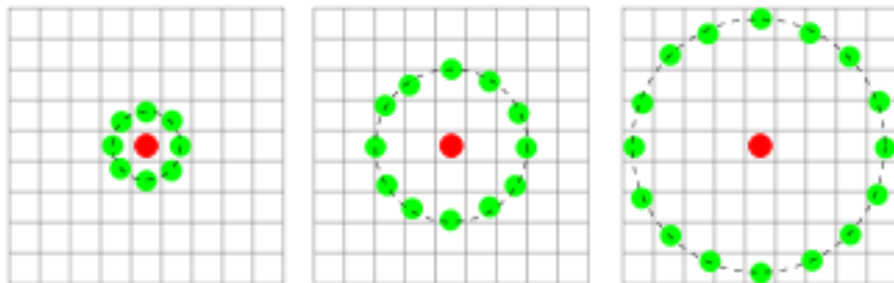




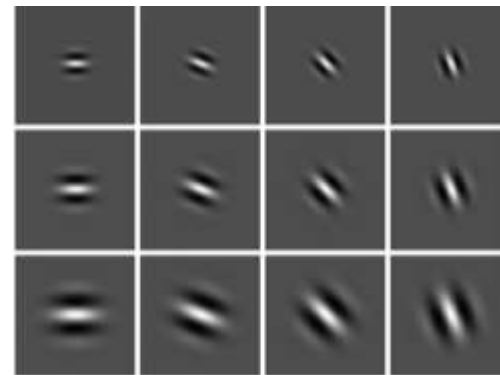
Identifikace třídy



$$f(x) = e^{-(x-x_0)^2/a^2} e^{-ik_0(x-x_0)}$$

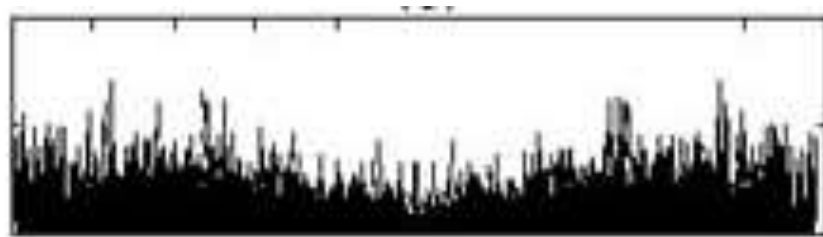
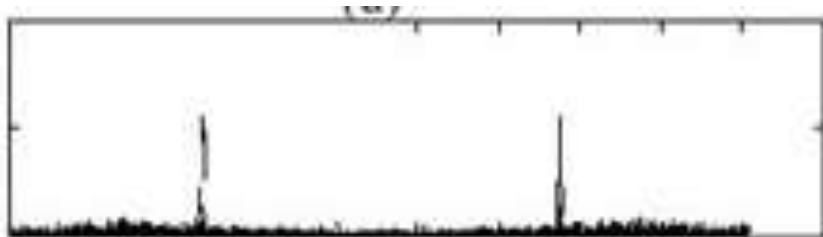
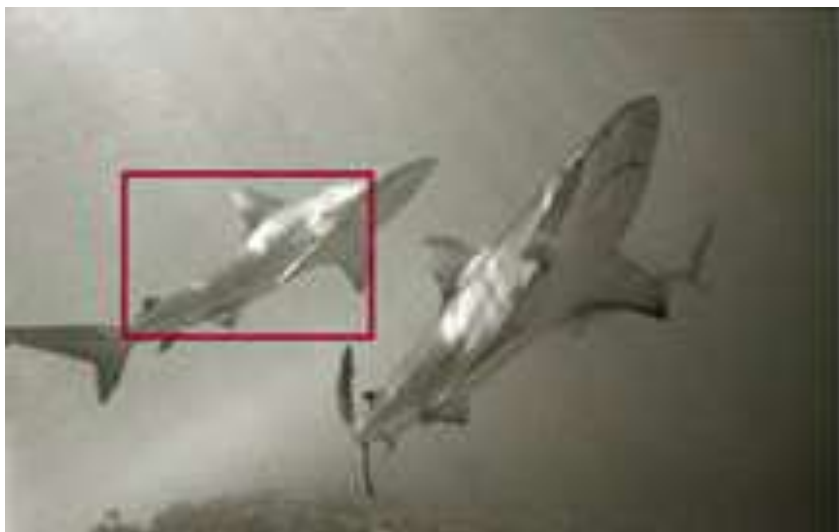


LBP (local binary patterns)



wavelety

Interpolace





DZ - duplikáty



$$B(p, q) = \mu_{pq} - \alpha \cdot \mu_{pq} - \frac{1}{\mu_{00}} \sum_{n=0}^K \sum_{i=m_1}^{m_2} \binom{p}{t-2i} \binom{q}{2i} \cdot B(p-t+2i, q-2i) \mu_{t-2i, 2i}$$

$$\mu_{pq} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (x - x_t)^p (y - y_t)^q f(x, y) dx dy$$



DZ - duplikáty





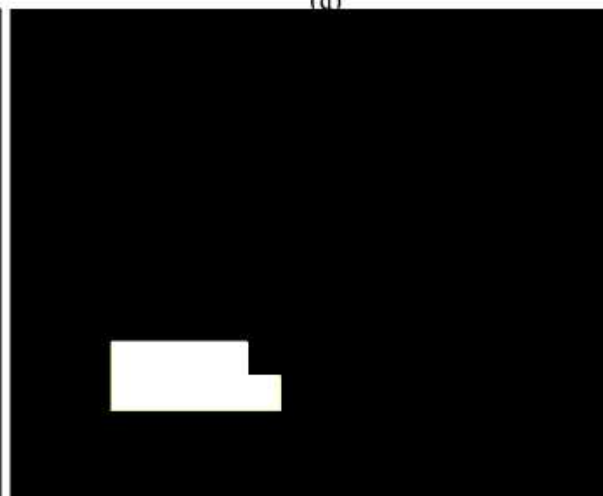
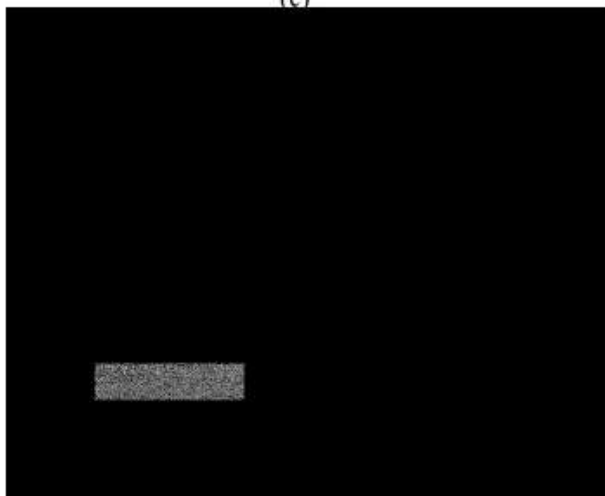
2. DZ – šum



(c)



(d)

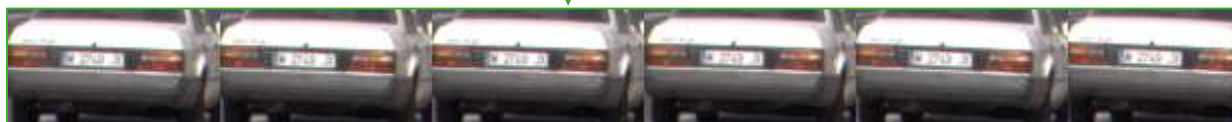




Zvýšení rozlišení



optical flow



SR snímek (2x)



optické zvětšení



vstup



výstup

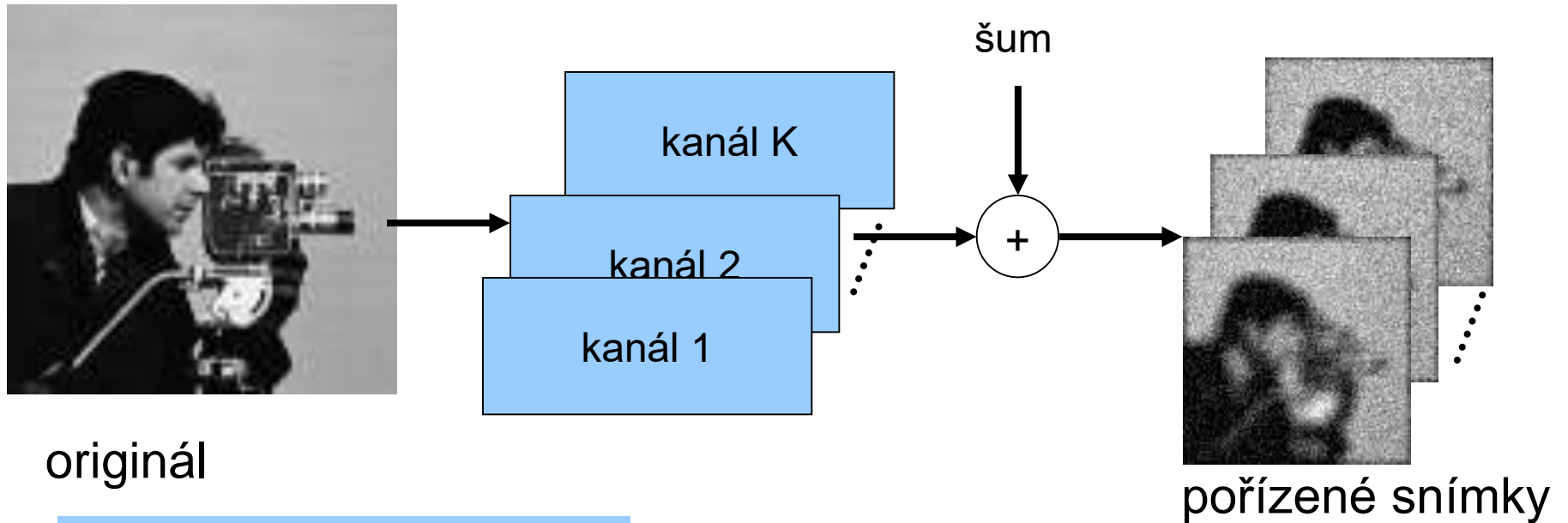


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Restaurace obrazu



$$D[H_k[u]](x)$$

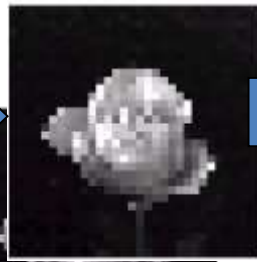
$$+ n_k(x) = z_k(x)$$



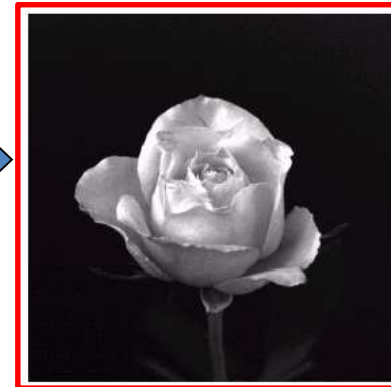
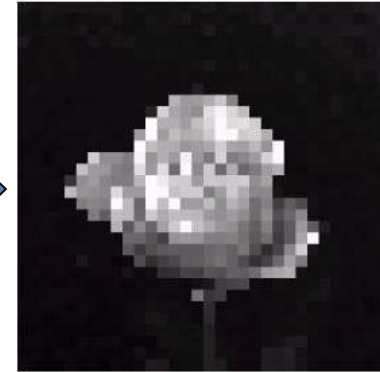
ideální scéna



snímání



interpolace



SR

$$E(u) = \frac{1}{2} \sum_{k=1}^K \|z_k - D_k(u)\|^2 + \lambda Q(u)$$





LR frames



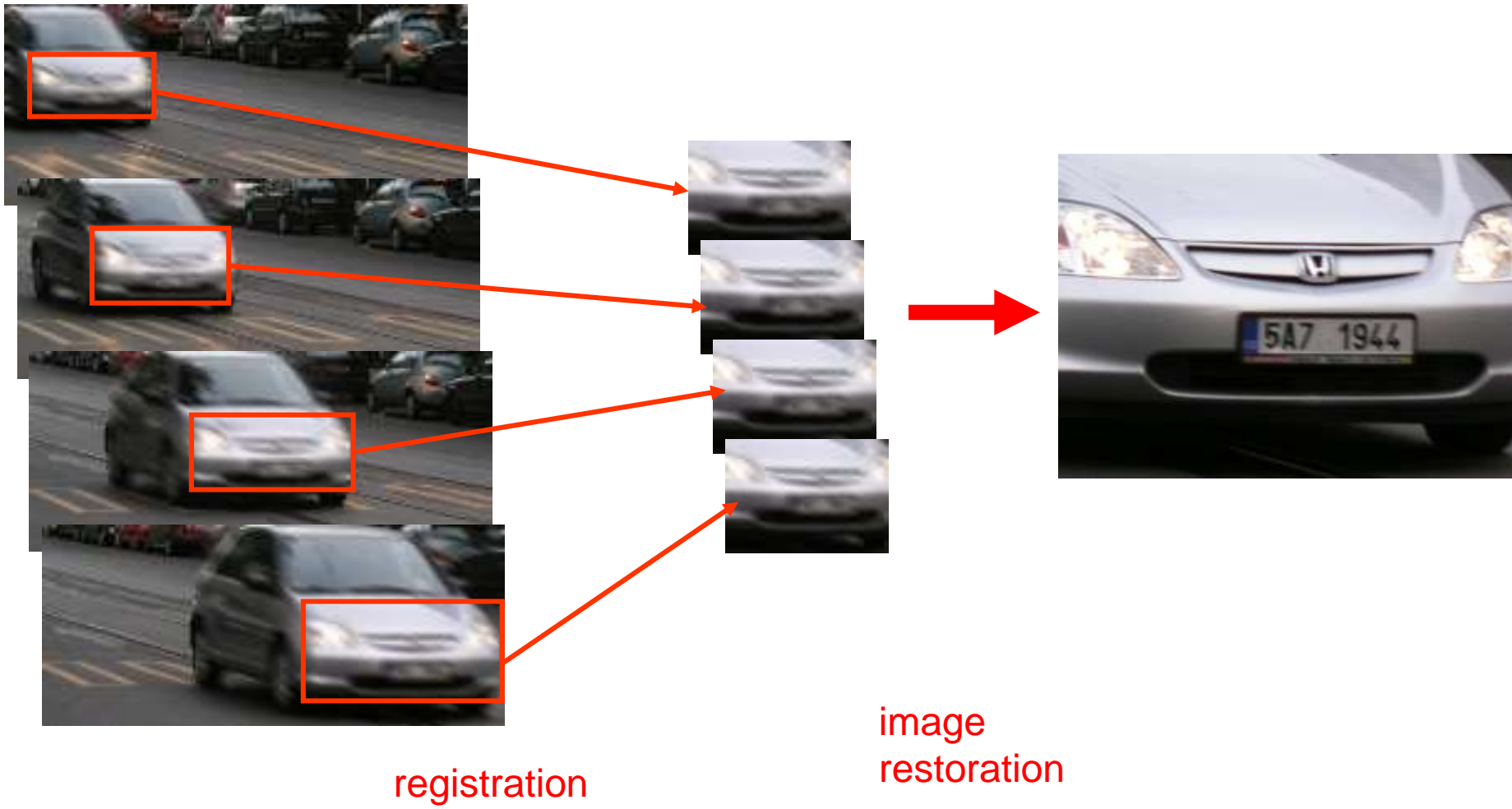
interpolated



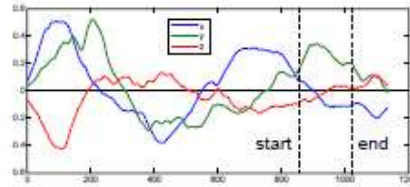
SR

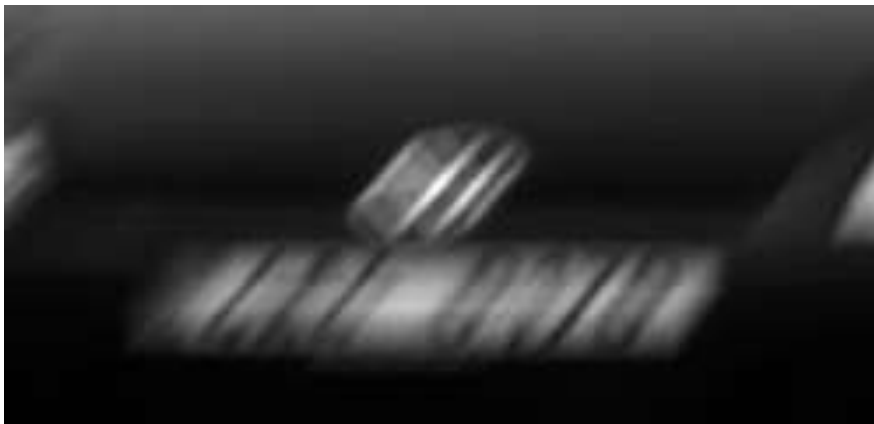
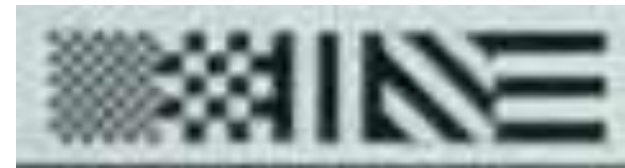
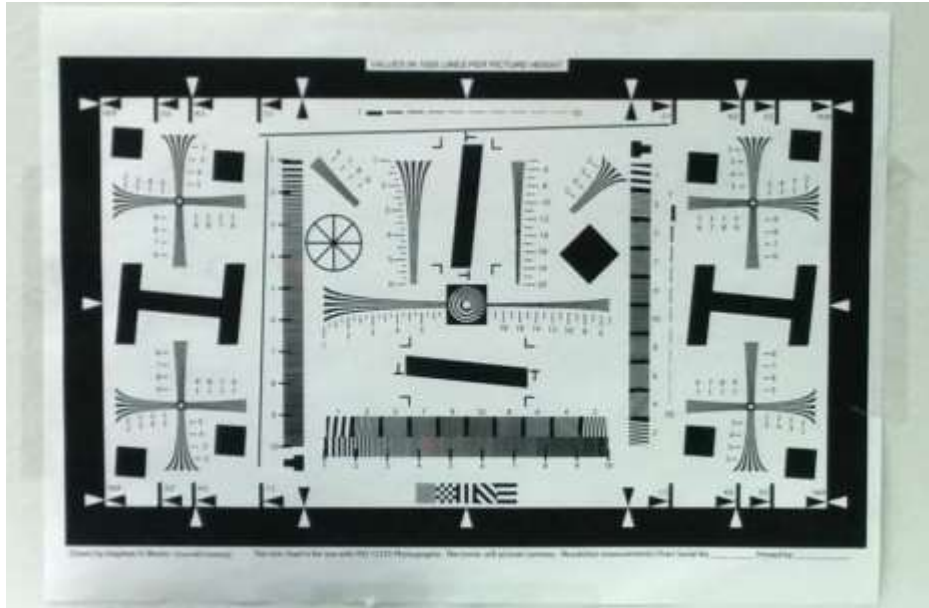


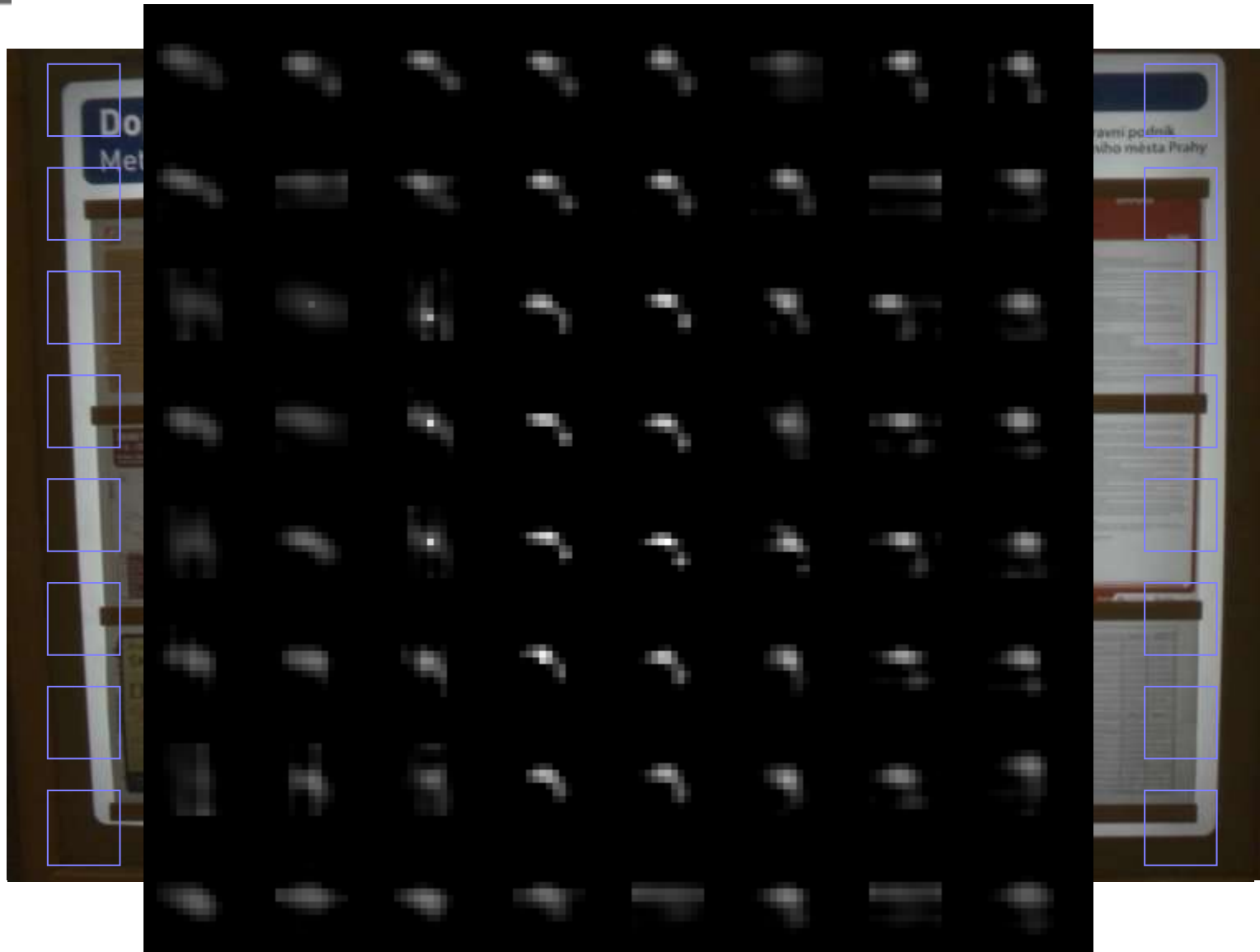
Original



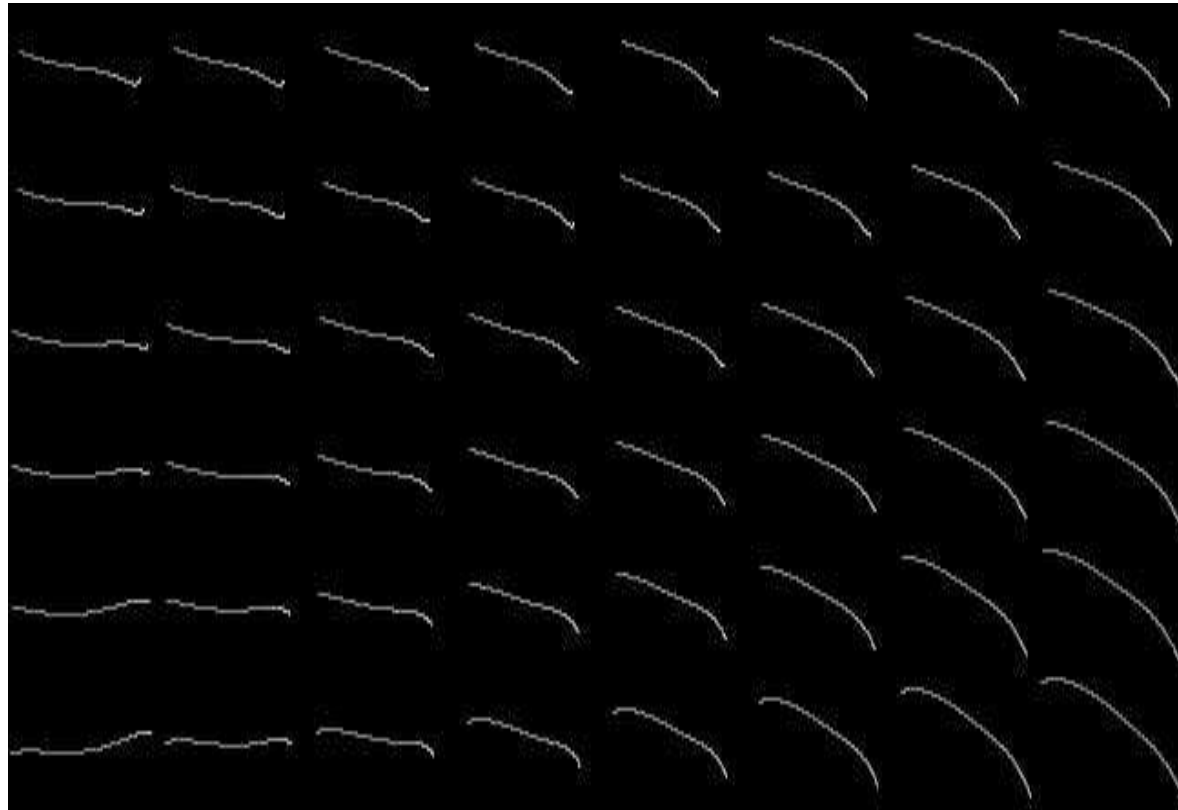




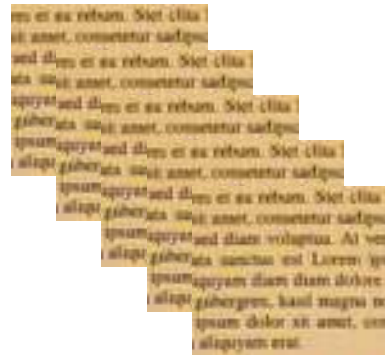




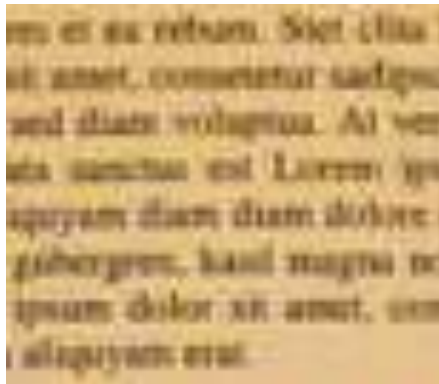




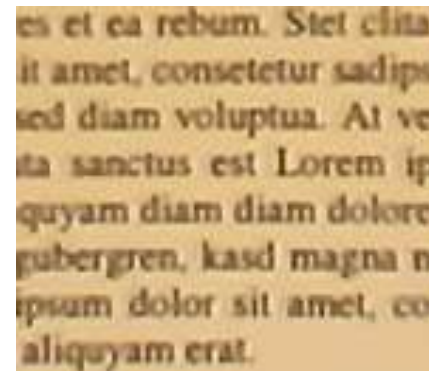




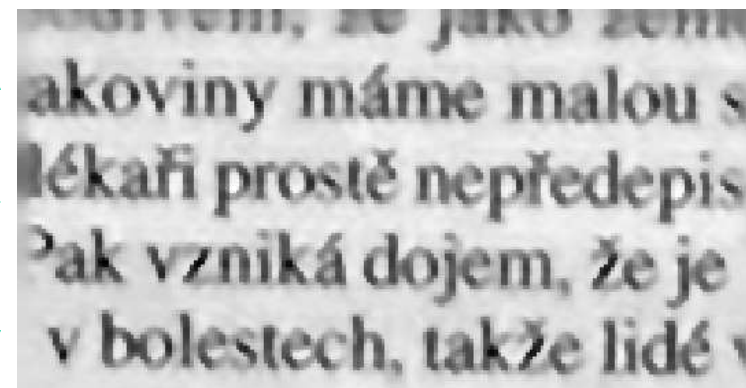
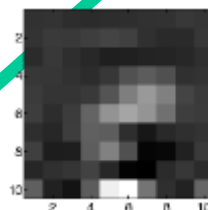
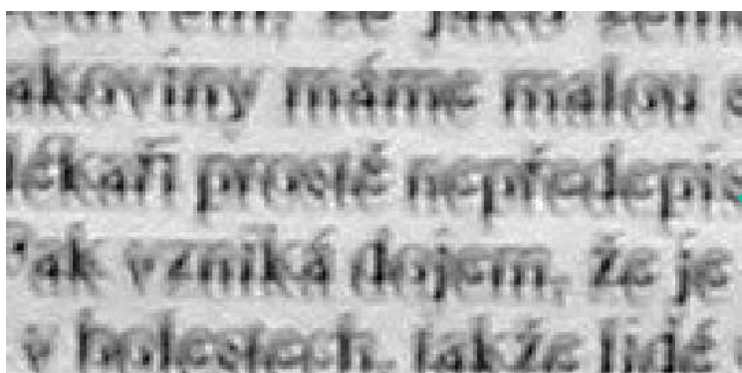
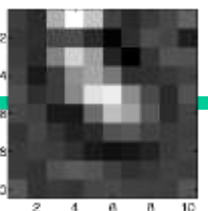
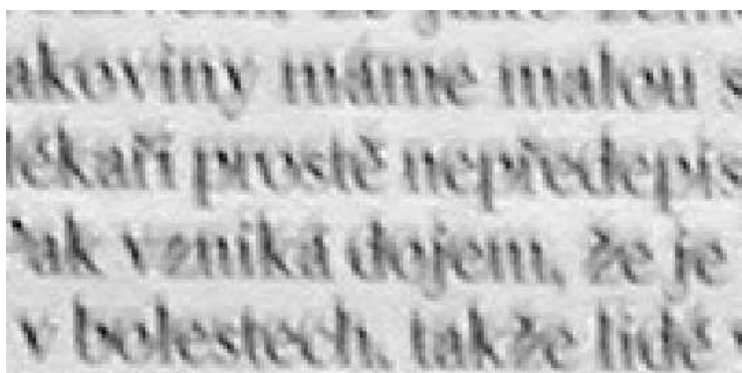
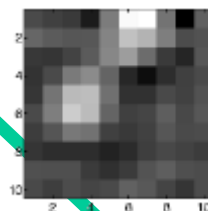
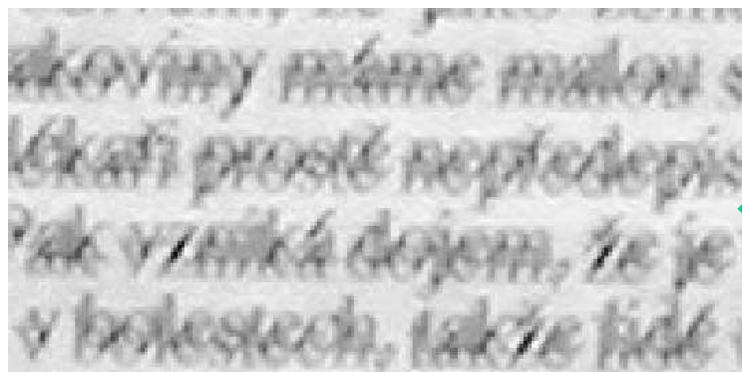
superresolution (zvýšení rozlišení)



Scaled



Superresolved
(2x)



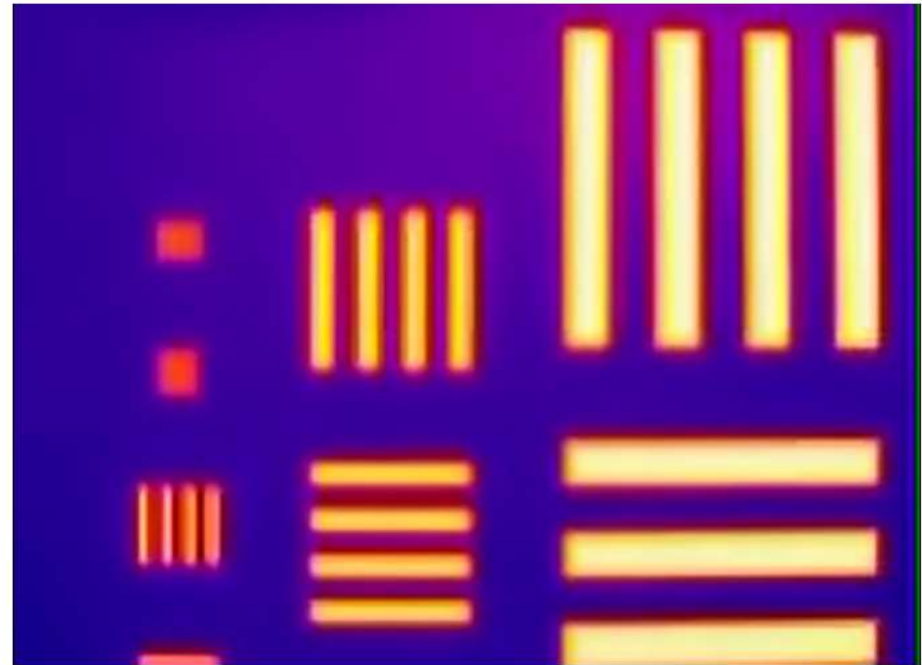
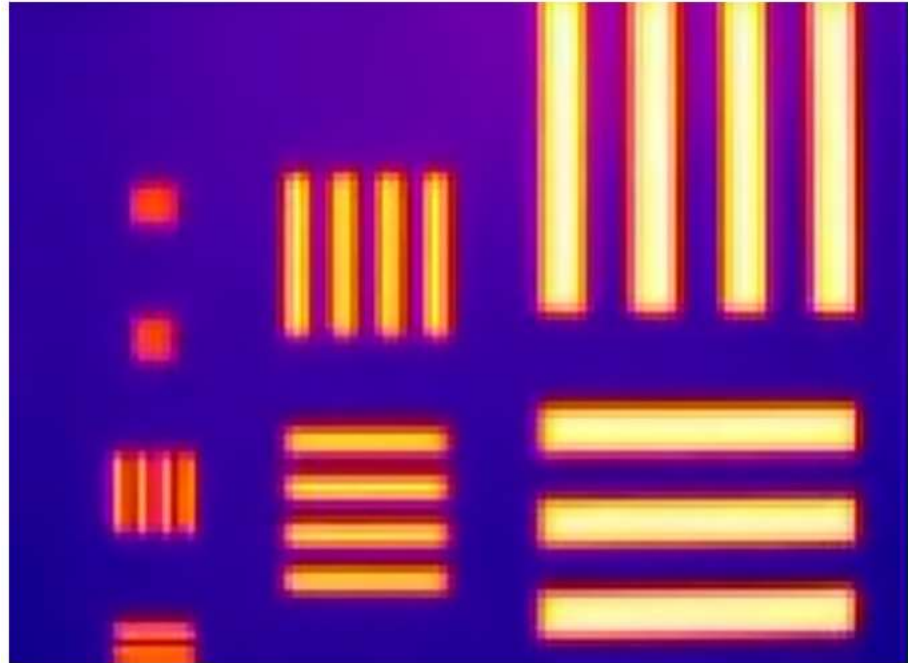
**dekonvoluce
(zaostření)**

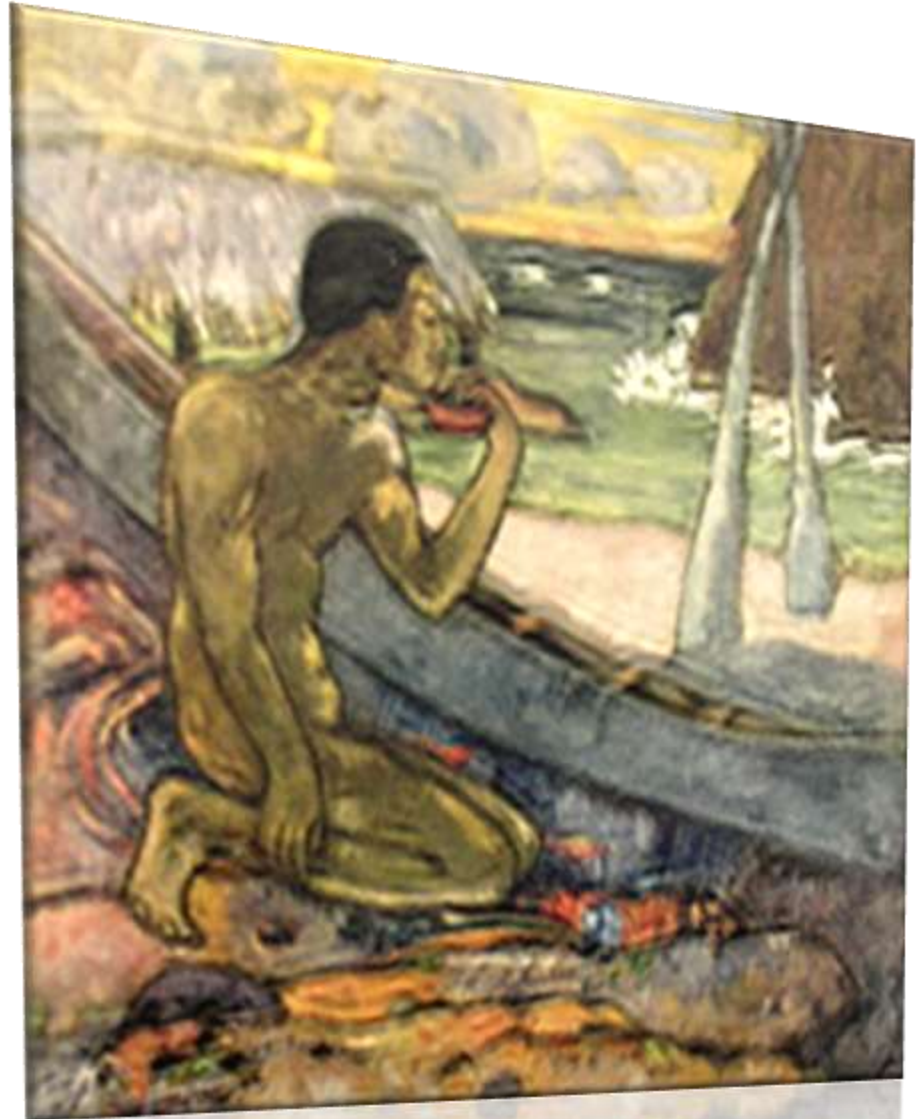
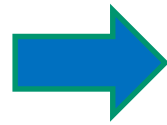


- **Ruční infračervená kamera**
 - 160 x 120, 9 fps
- **Real-time zvýšení rozlišení**
 - s faktorem 2 (320 x 240)
 - výpočet přímo na DSP
 - čipu kamery











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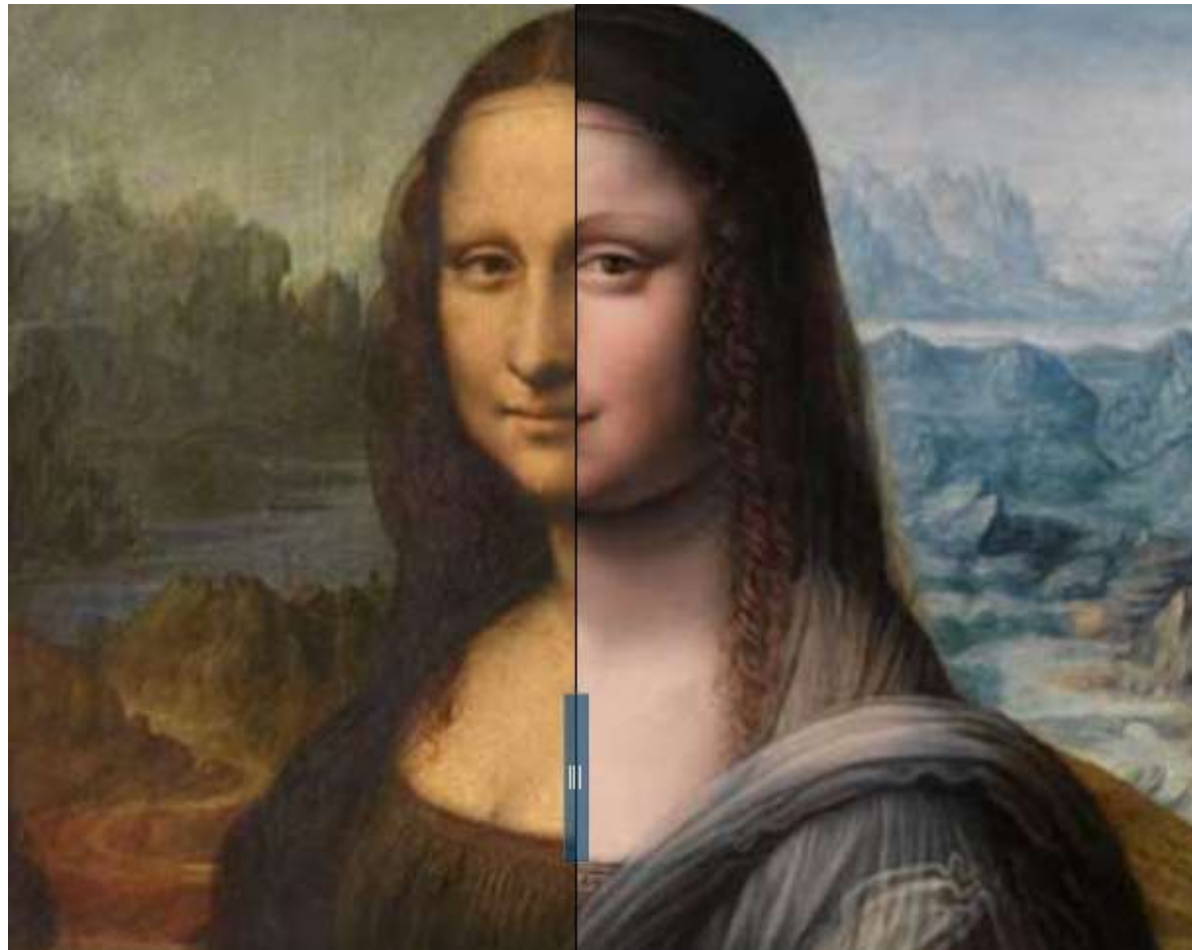
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Analýza obrazů



© Reuters

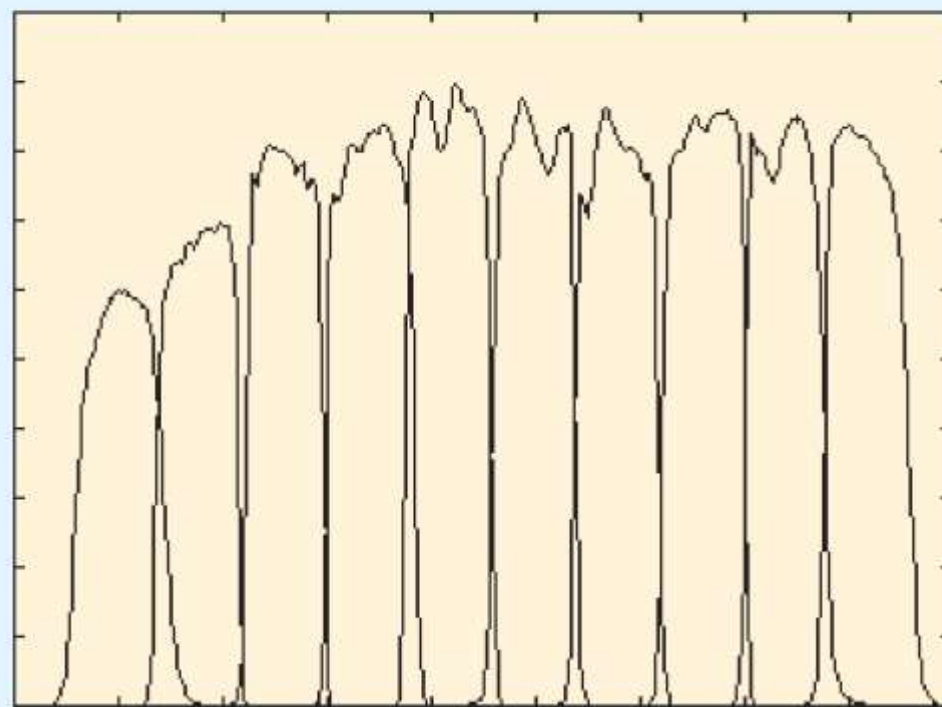


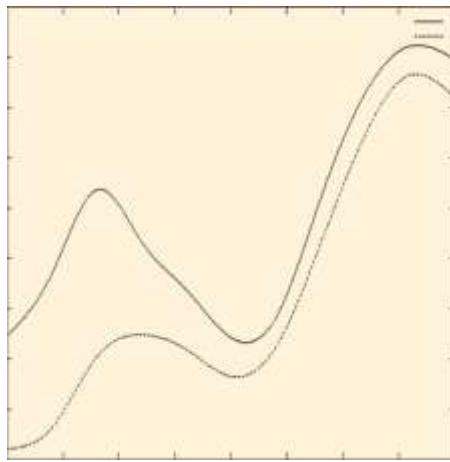




Centre de Recherche et de Restauration des Musées de France.

350-800 nm

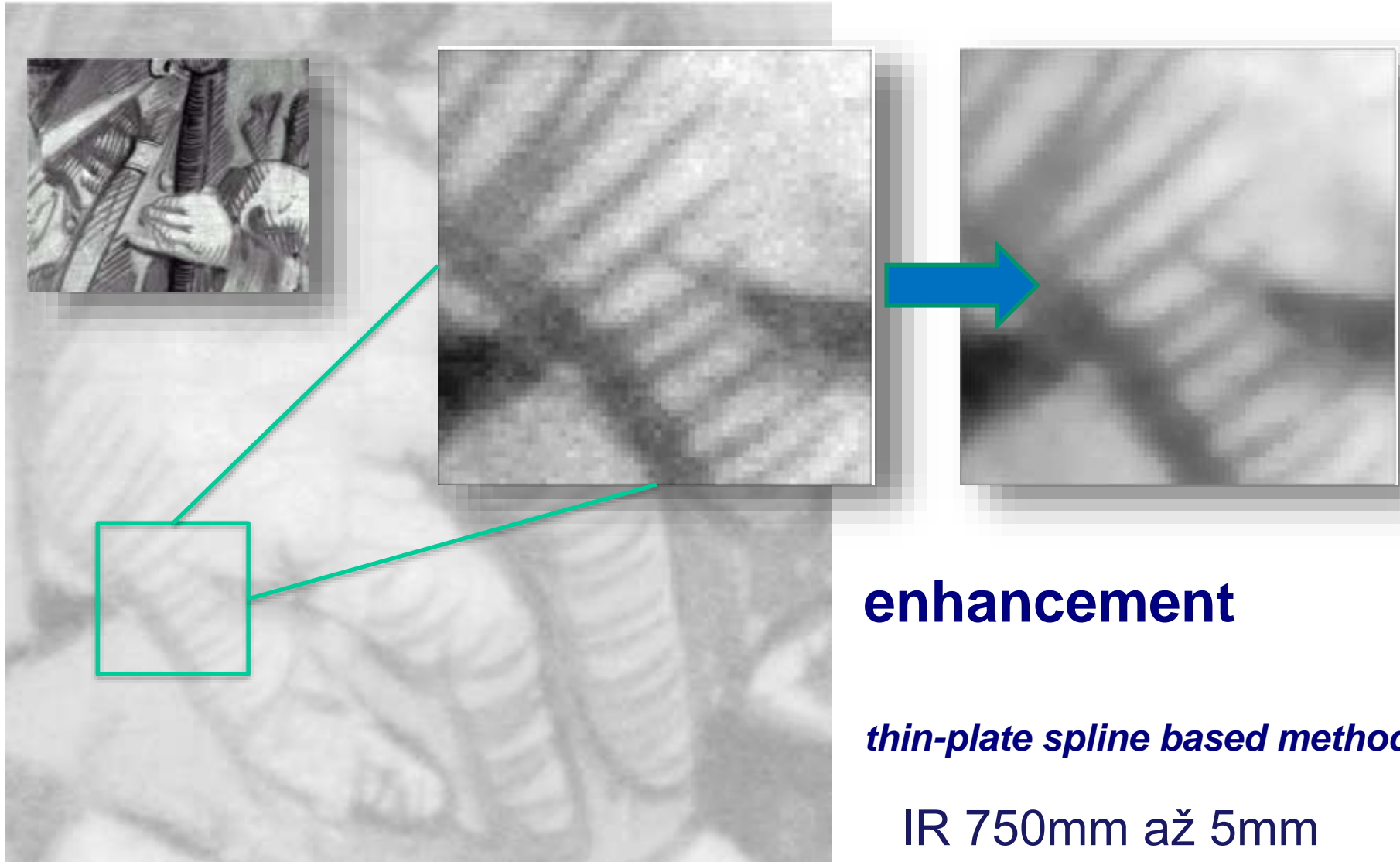




Alejandro Ribés, Ruven Pillay,
Francis Schmitt, and Christian Lahanier



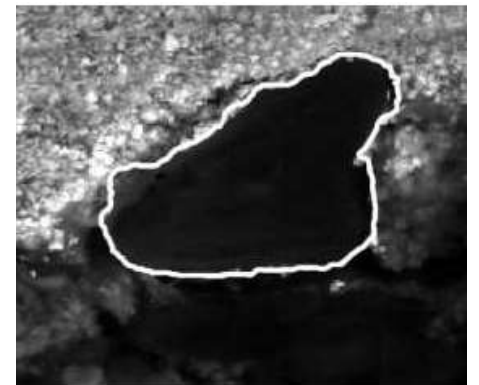
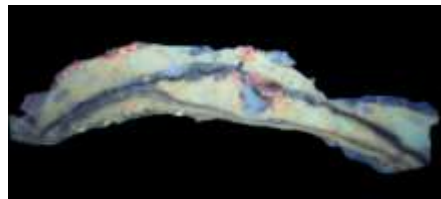
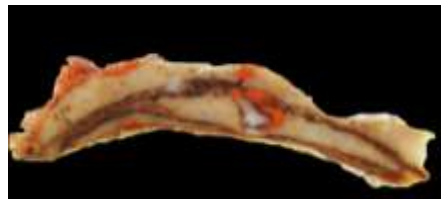
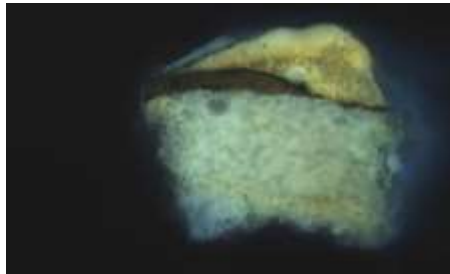




enhancement

thin-plate spline based method

IR 750mm až 5mm





**Olejomalba Marianne Norman von Ehrenfels
F. Amerling**



viditelné spektrum



IR spektrum

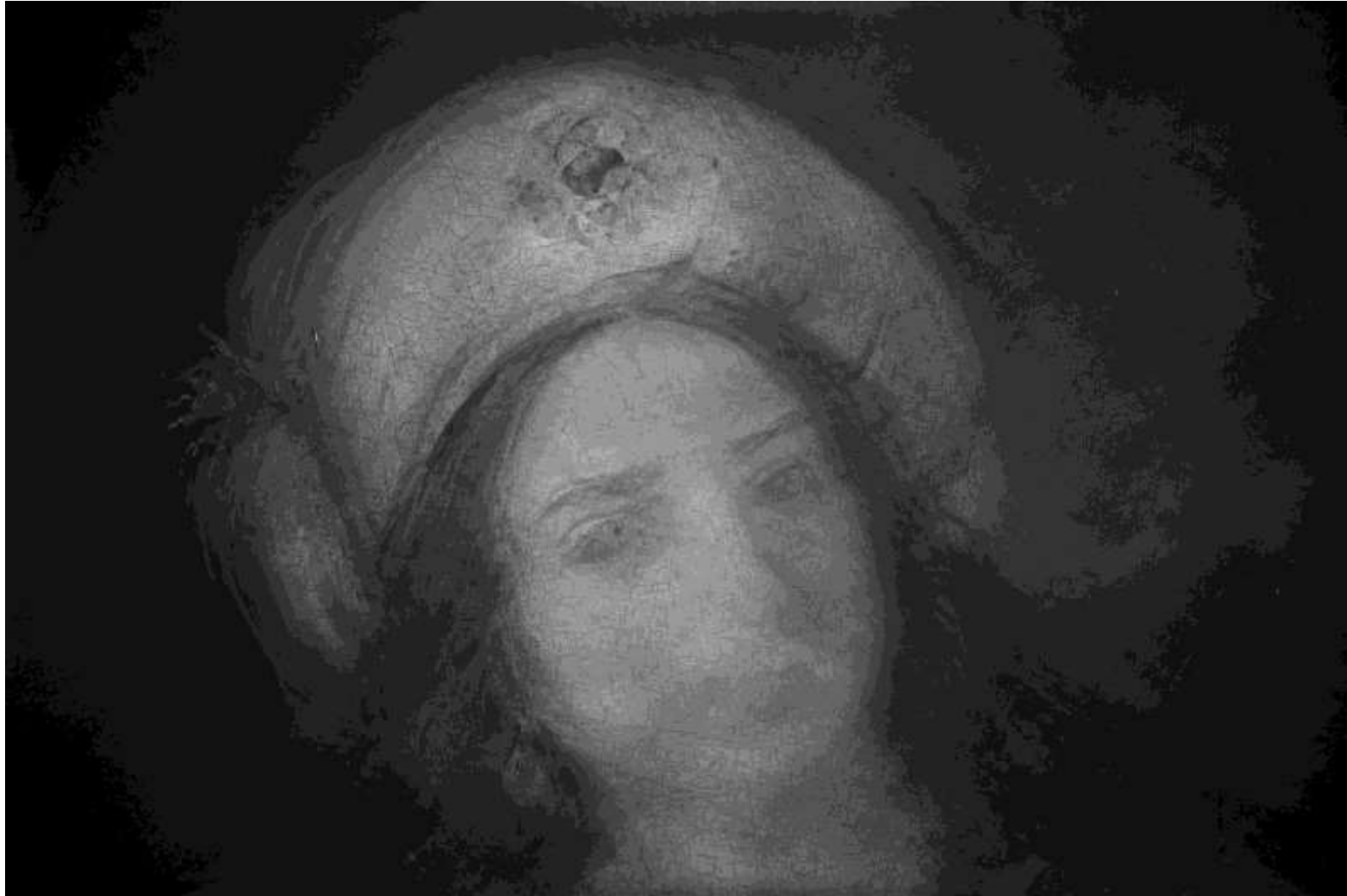




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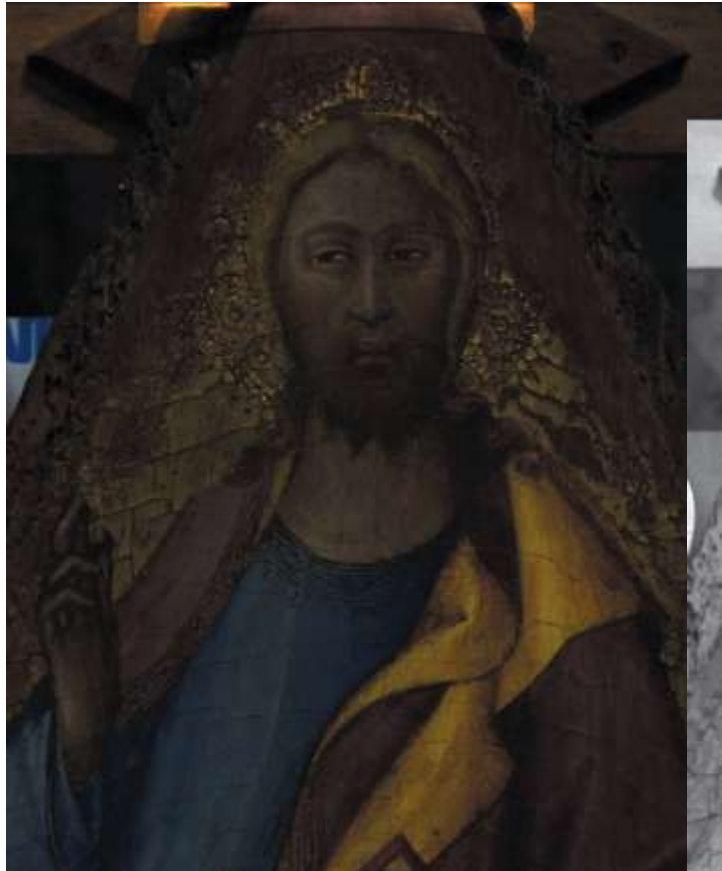




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**Simone Martini
(A. Pellagoti et al.)**

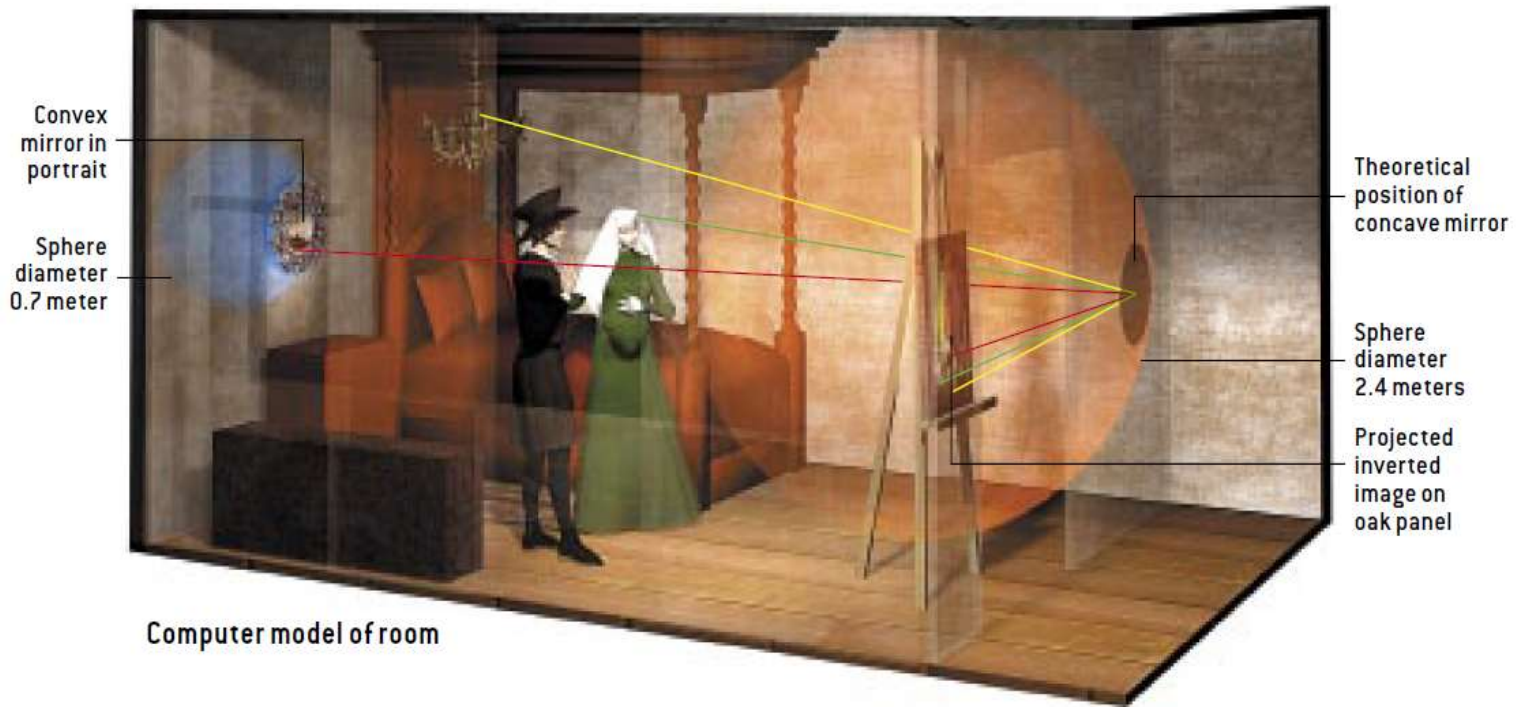


David G. Stork

pin-hole camera

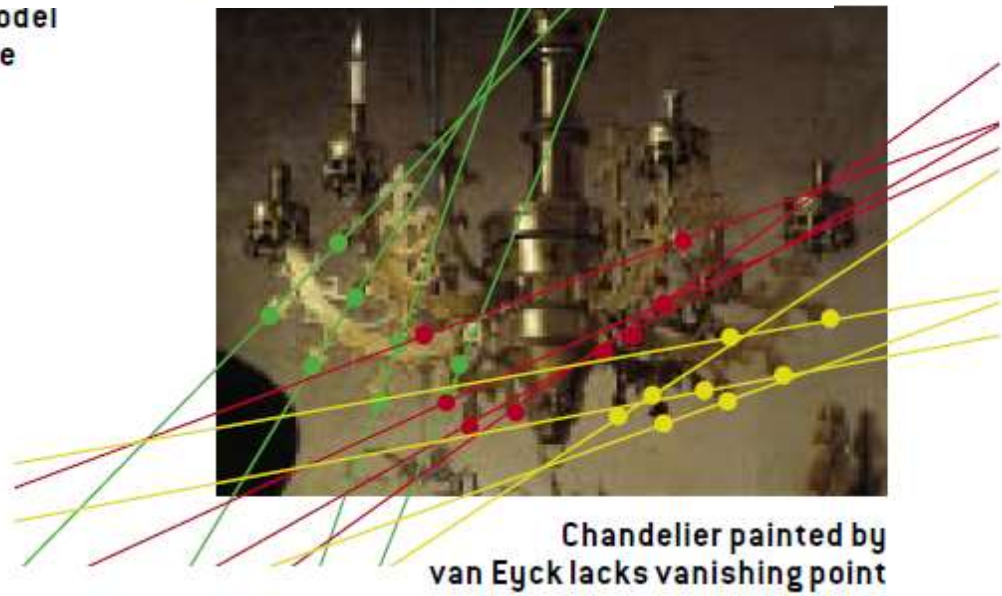
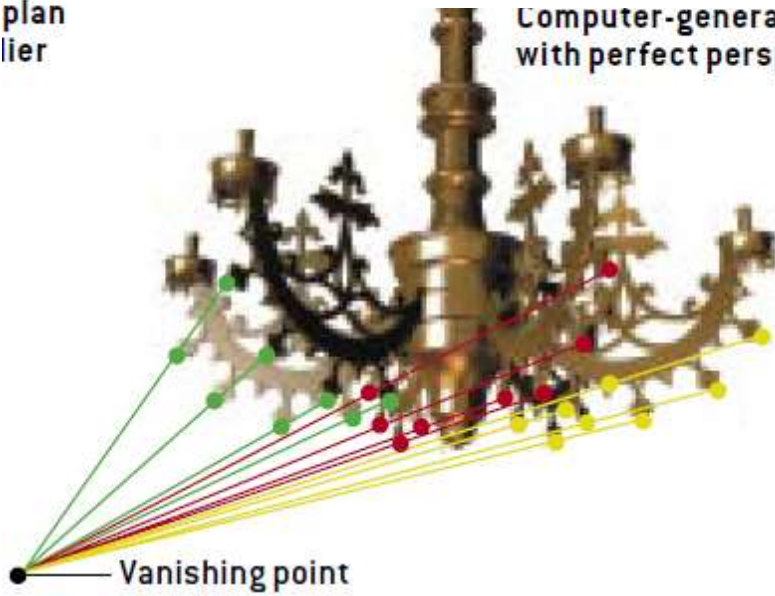
Portrait of Giovanni Arnolfini and His Wife, Renaissance
Jan van Eyck (1390?–1441),





plan
lier

Computer-generated model
with perfect perspective



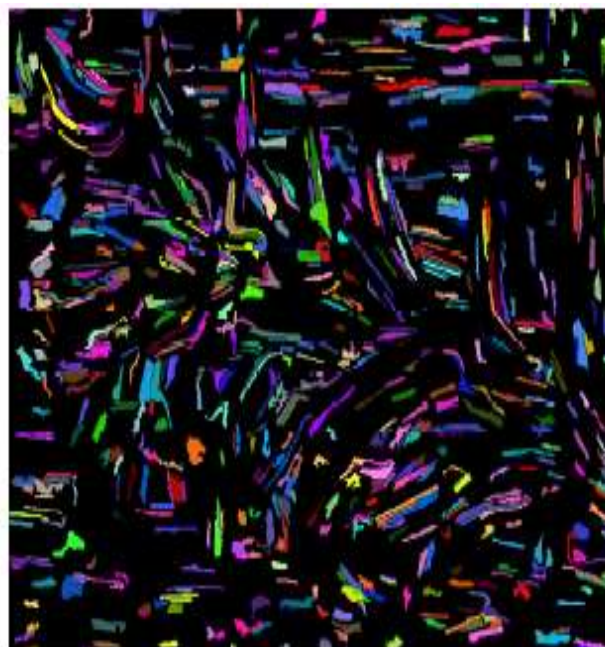


Ověření autorství

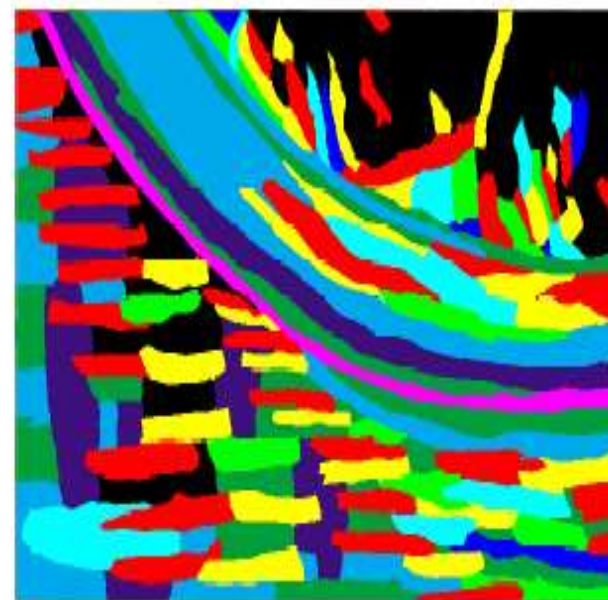
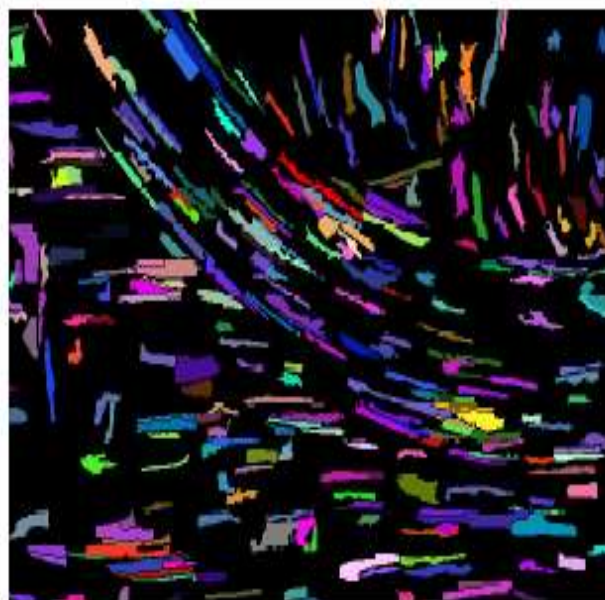
C. Richard Johnson, Jr., E. Hendriks, I. J. Bereznoy, E. Brevdo, S. M. Hughes, I. Daubechies, Jia Li, Eric Postma, and James Z. Wang

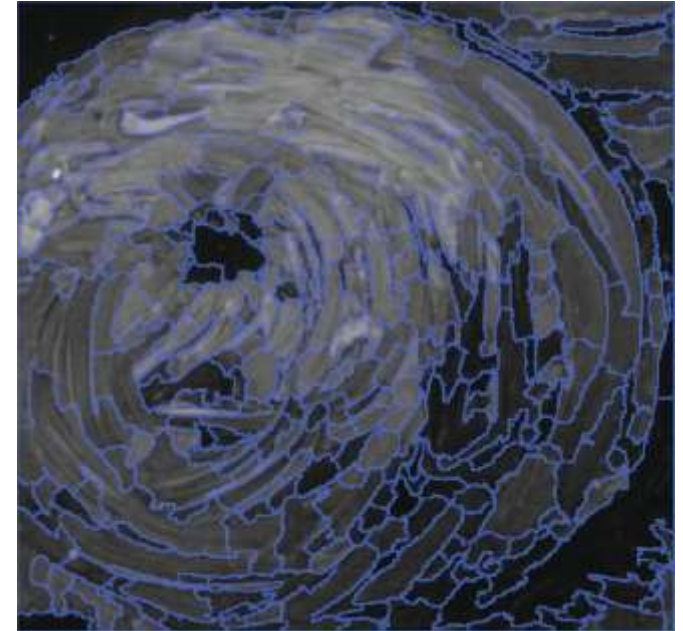
- Van Gogh a Kröller-Müller Museum





J. Z. Wang et al. Penn State Uni







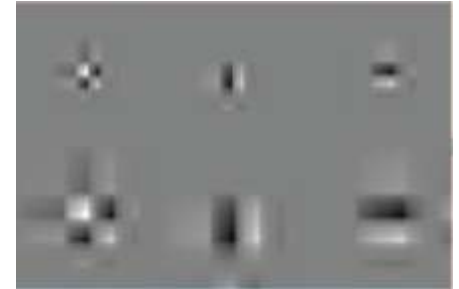
Gauguin



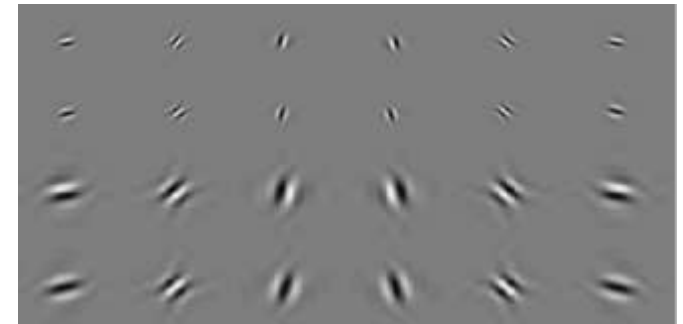
Van Gogh



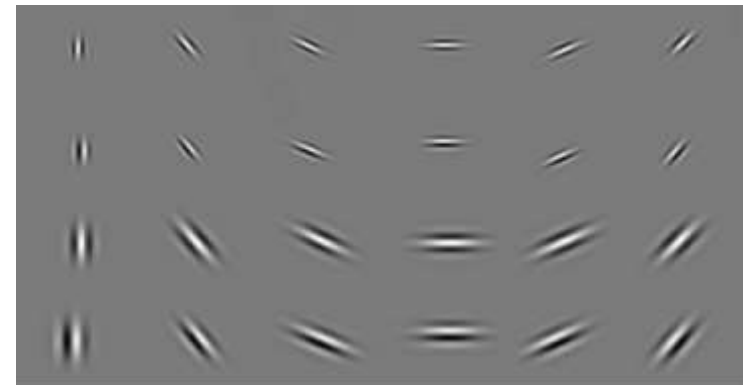
**-Penn State :
orthonormální wavelety (Daubechies)**

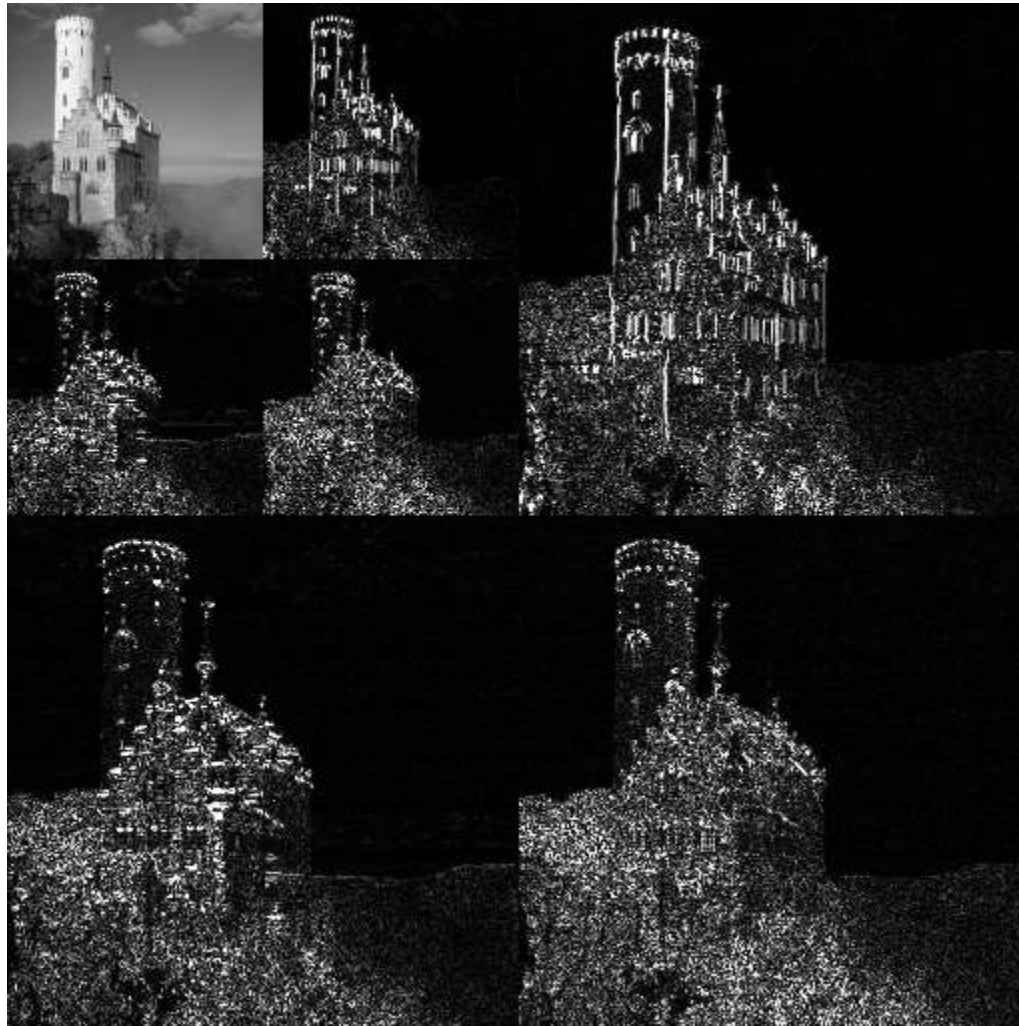


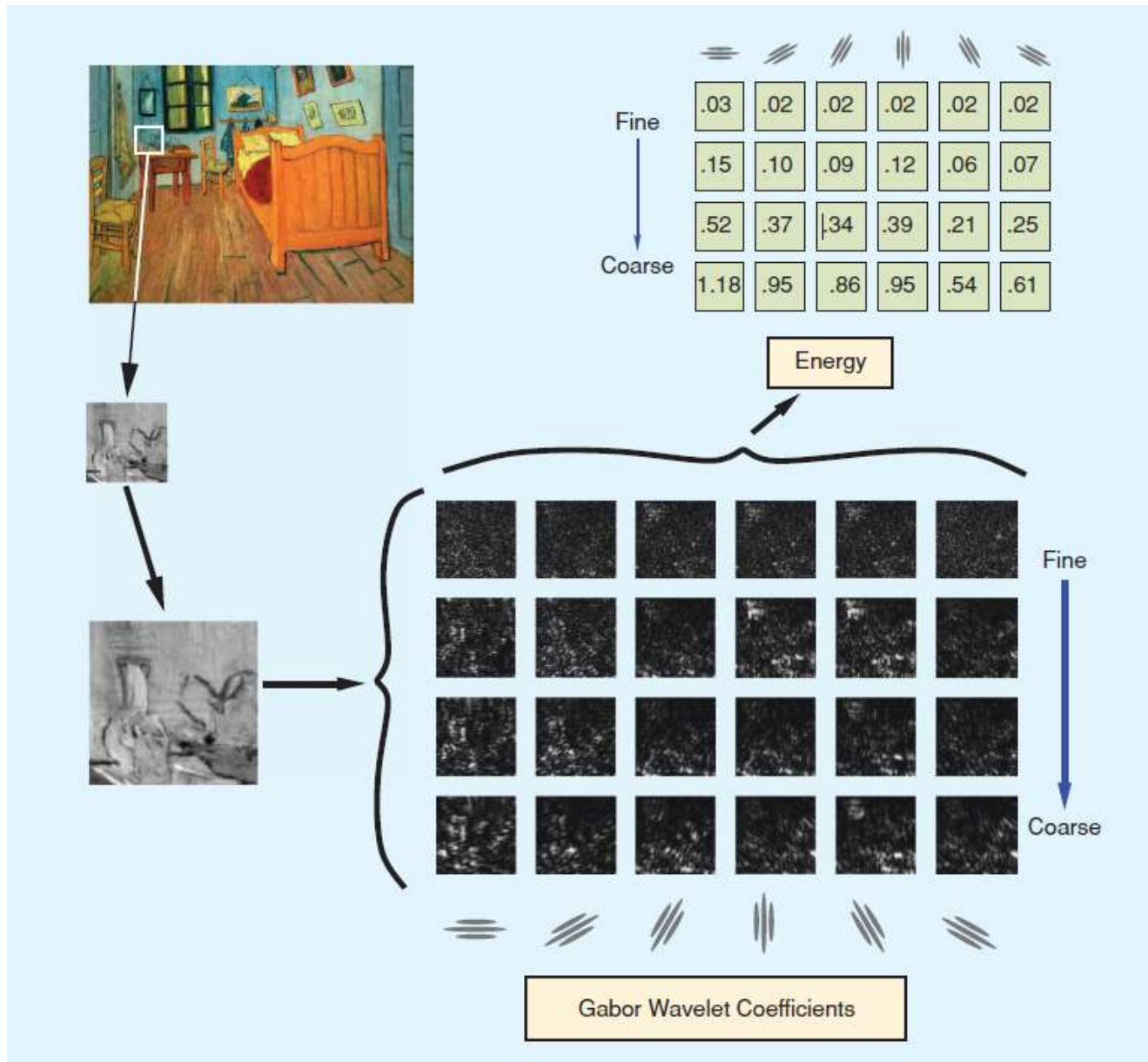
- Princeton : komplexní wavelety



- Maastricht : Gabor wavelety









Otto Wacker

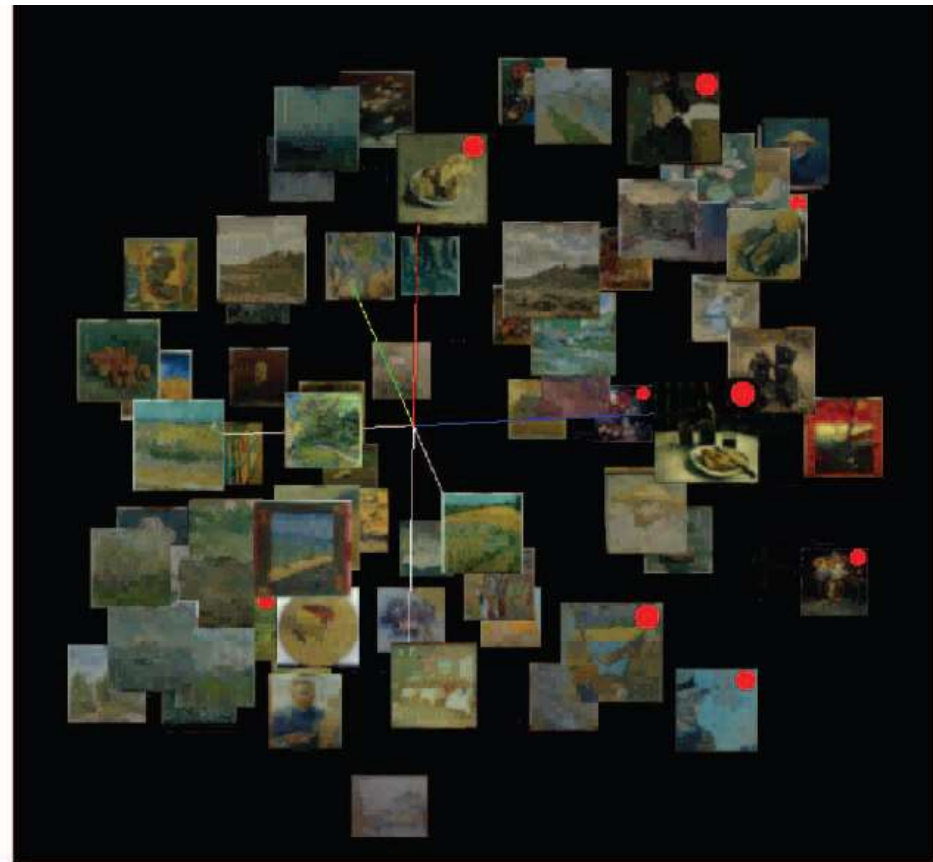
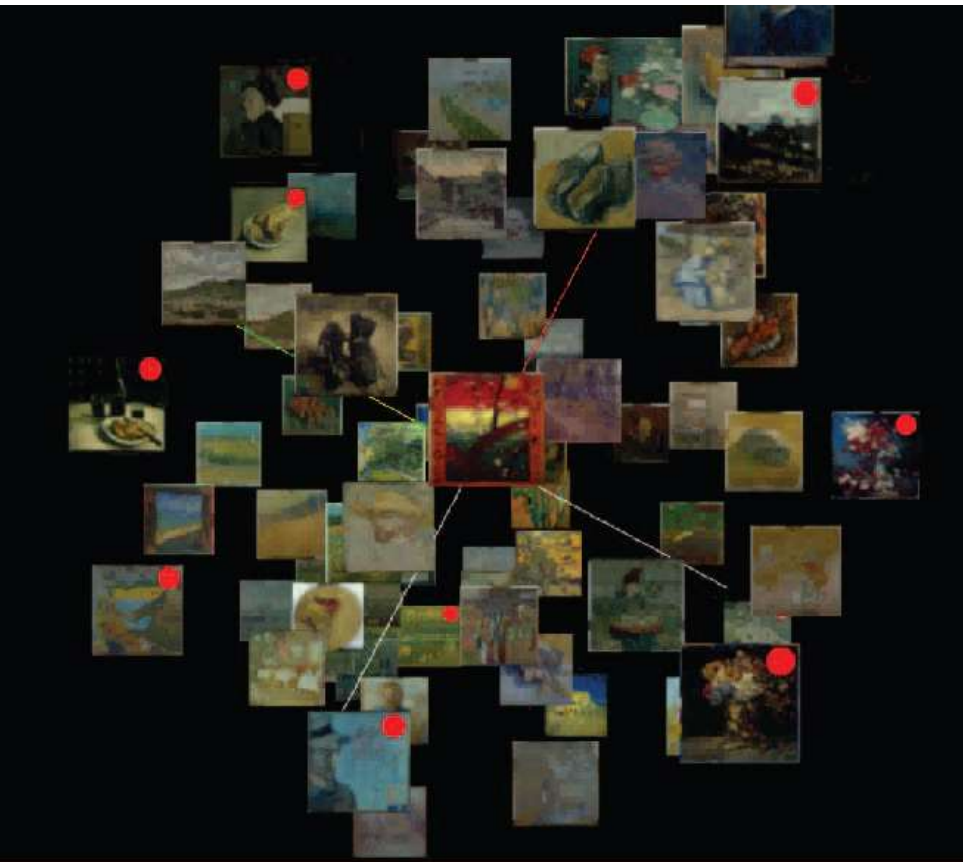
často vysoké hodnoty wvl koeficientů

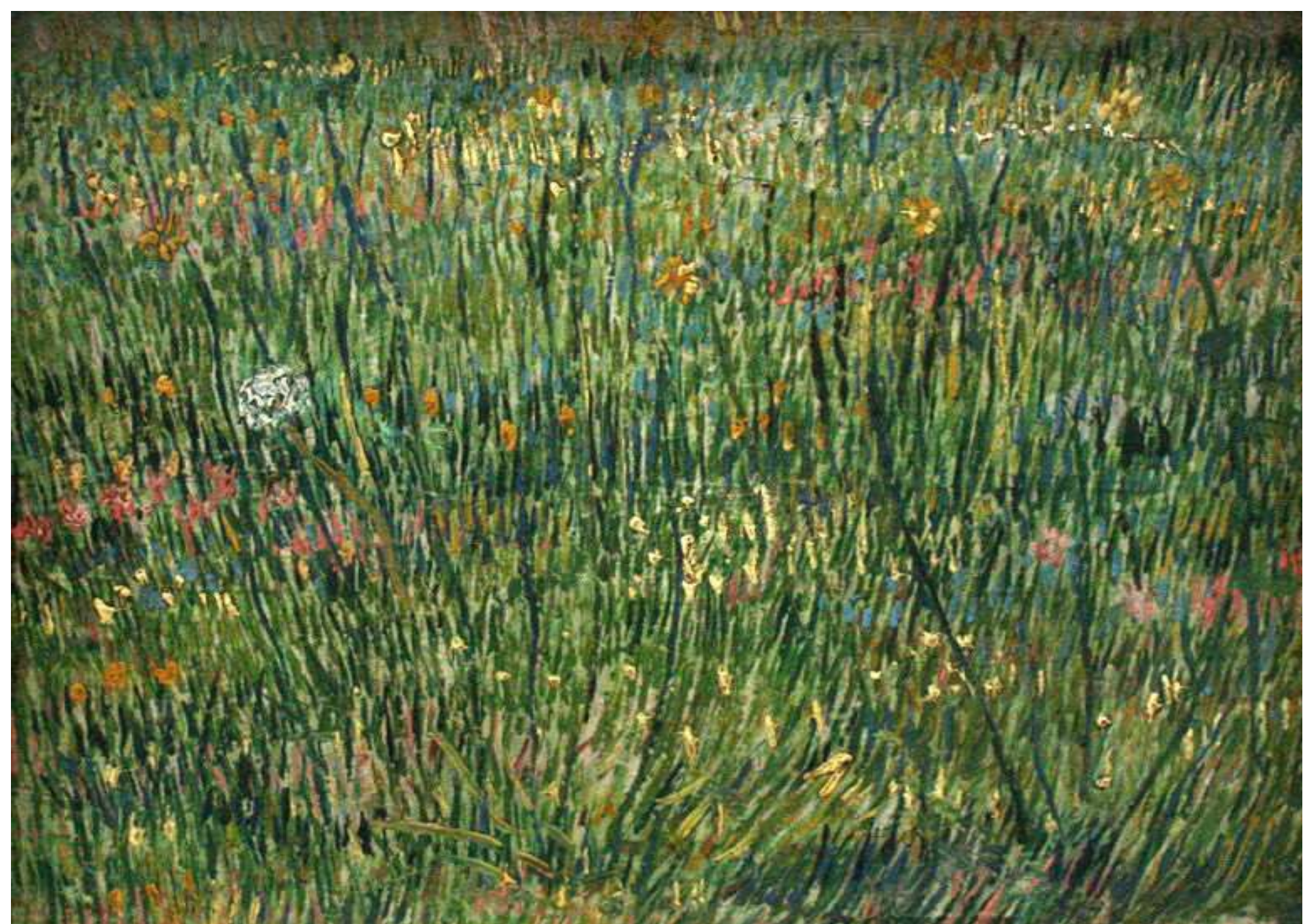
velké koeficienty na jemných úrovních

=> nerozhodné tahy

=> míra definovaná na mediánu koeficientů na 2
nejjemnějších úrovních



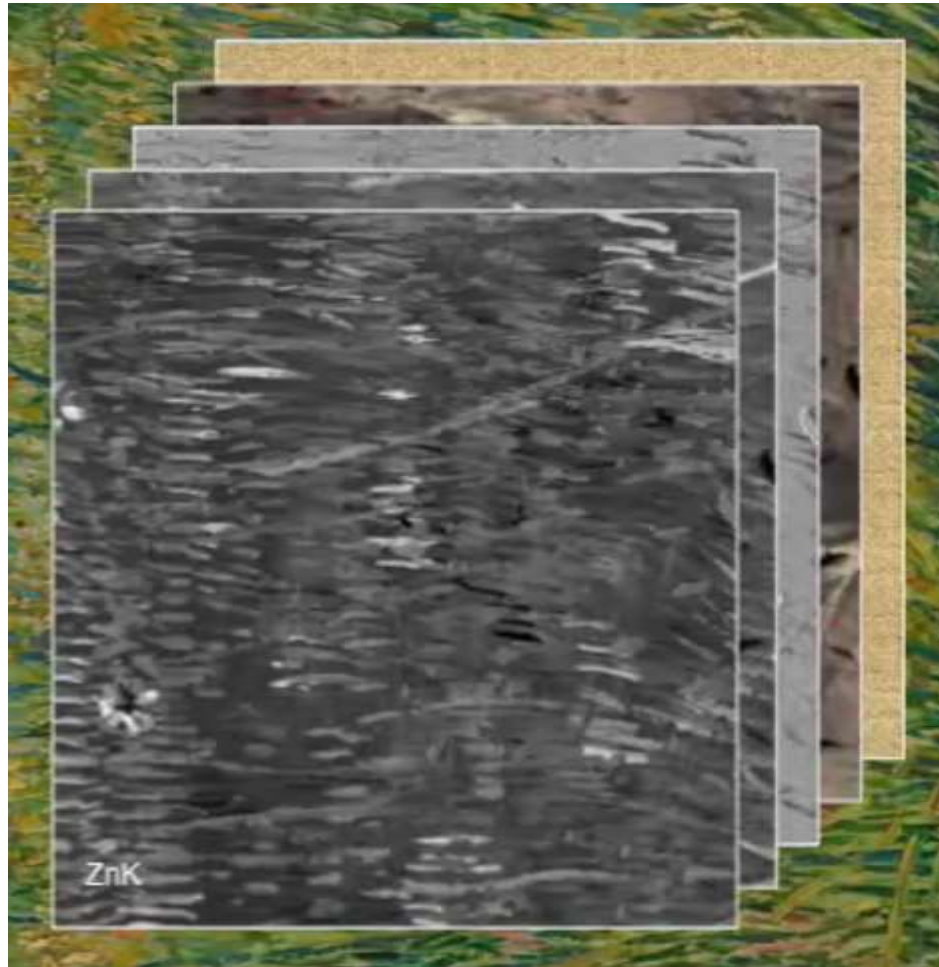




Patch of Grass, 1887



Patch of Grass, 1887, synchrotron radiation induced X-ray fluorescence spectroscopy



Rtuť a antimon

synchrotron radiation induced X-ray fluorescence spectroscopy



Patch of Grass, 1887, synchrotron radiation induced X-ray fluorescence spectroscopy



other, existing painting by Van Gogh



a

b

c

Edgar Degas: Portrét ženy



a



Edgar Degas: Portrét ženy



Budoucnost

... nebo současnost ?



NEIL - Never Ending Image Learner

Carnegie Mellon University

24/7 automatická extrakce vizuální znalosti z Internetu

Běží od 15.7. 2013, přes 5 mil obrázků, 3000 vztahů

Semi-supervised, macro vision

Google image search



Hero_cycles



Kettle



Jeep



Big_ben



Mitten



Kenworth_t2000



Chess



Teapot



Wolf



Ant



Festiva



Sedan



Croissant



Bookshelf



Train



Pocket_bike



Datsun_sentra



Robot



NEIL - Never Ending Image Learner



Airbus_340 can be a kind of / look similar to Airplane.

Cessna_aircraft can be a kind of / look similar to Airplane.

Lufthansa_plane can be a kind of / look similar to Airplane.



DEPARTMENT OF IMAGE PROCESSING

INSTITUTE OF INFORMATION THEORY AND AUTOMATION



Ex machina





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Děkuji za pozornost



MFF UK, FJFI CVUT, ...

Digital Image Processing

Special Functions and Transformations in Image Processing

Variational methods in image processing

Statistical pattern recognition and decision making methods

Advanced Seminar On Image Processing

Digital Image Processing in Practice

PhD students, PhD graduates

Master and Bachelor students

Spring and Winter school of Image Processing