

Digital Image Falsification Detection

Should you believe what you see?

Vincent Nozick



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Introduction


Presentation :

- McF Université Paris-Est Marne-la-Vallée
 - LIGM-A3SI
 - JFLI
- first: computer vision
- then:
 - geometric algebra
 - digital image forensics

Image forgery: from amateurs to pro ...

In only ONE Month
You Can do it too

Register
Now!!!



Photoshop Courses
The best tool to change your body

Social networks



Magazine



before and after

Internet: hoaxes



Michael Jackson still alive?

Internet: serious hoaxes



Giant skeleton

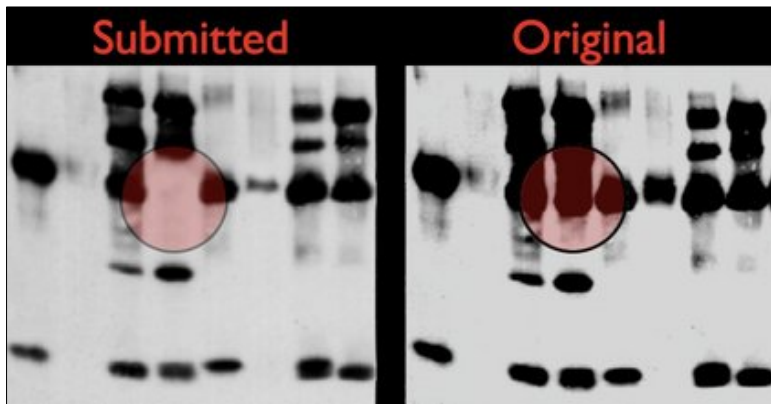
Press



Los Angeles Times (2003)

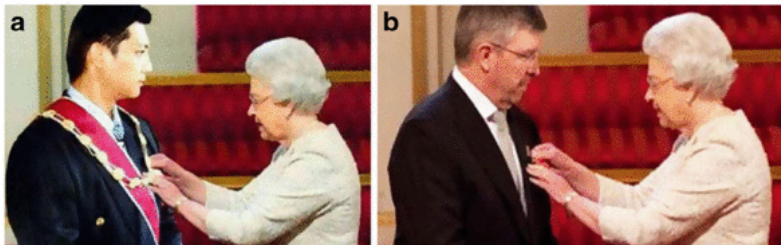
→ photographer fired

Science



Journal of Clinical Investigation (2005)

Politics: Jeffrey Wong Su En



Jeffrey Wong Su En (2010)

He claimed to have been knighted by the Queen Elizabeth II

Propaganda



Iran (2008)
to hide that 1 of the missile didn't launched

Propaganda



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Propaganda



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Practical applications

- **Police** : to get a good lead in investigations.



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Practical applications

- **Police** : to get a good lead in investigations.
- **Justice** : for authentication of a proof.
- **Press** : for authentication of a news.
- **Economy** : to prevent some attacks.
- **Intelligence and spying** : to distinguish between the true and the false.



State of the art

Image inconsistencies:

- jpeg artifacts
- optic and geometric inconsistencies
- ...

Falsification traces:

- copy-past
- manual modification
- ...

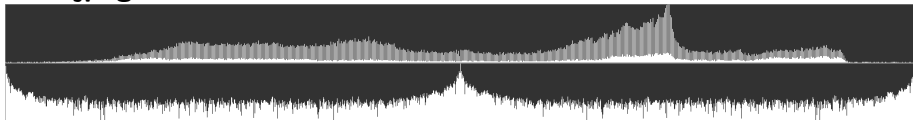
Double jpeg

Double jpeg detection :

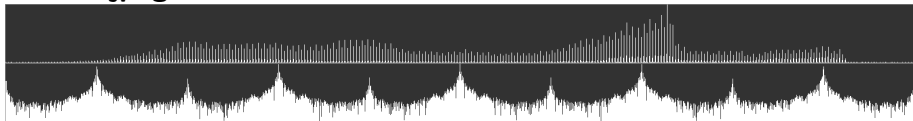
Popescu and Farid 2005

- ① compute the histogram of the selected quantization coefficient
- ② compute the 1d Fourier Transform of the histogram → smoothness

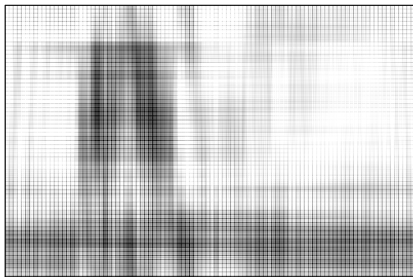
First jpeg save :



Second jpeg save :



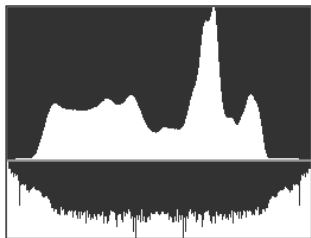
Retreive jpeg quantization tables



Estimage the quantization table:

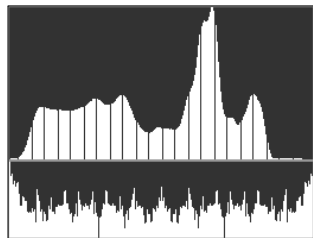
Sun and Chang 2007

Brightness contrast



→ detect brightness change : Stamm et al. 2008

Brightness contrast



→ detect brightness change : Stamm et al. 2008

Copy-move



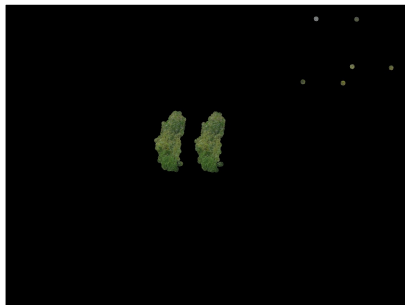
Copy-move



Copy-move



Copy-move



Copy-move



Copy-move



Copy-move



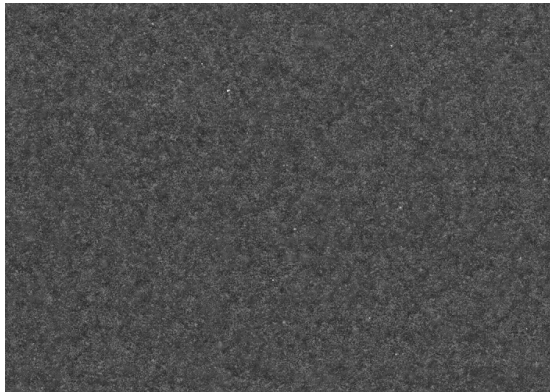
Copy-move



Camera sensor noise



Sensor noise



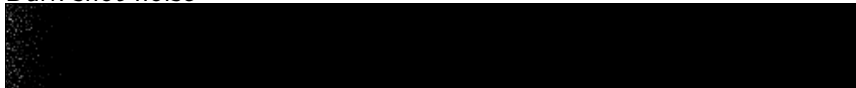
30 secondes in complete dark

↗ contrast and zoom $\times 3$

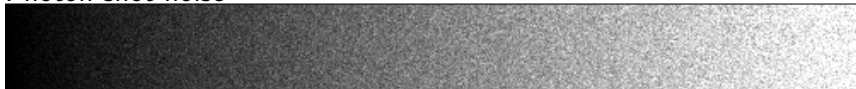
Sensor noise

Combination of several noises:

- Dark shot noise



- Photon shot noise



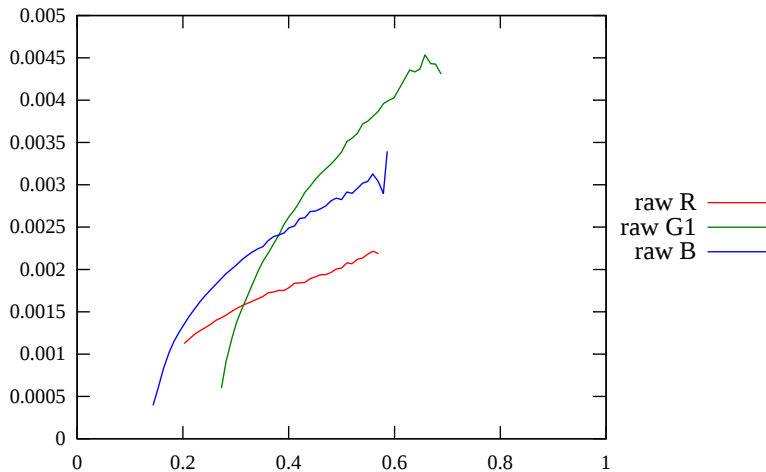
- Fixed pattern noise



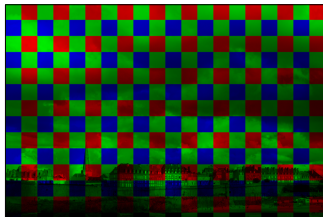
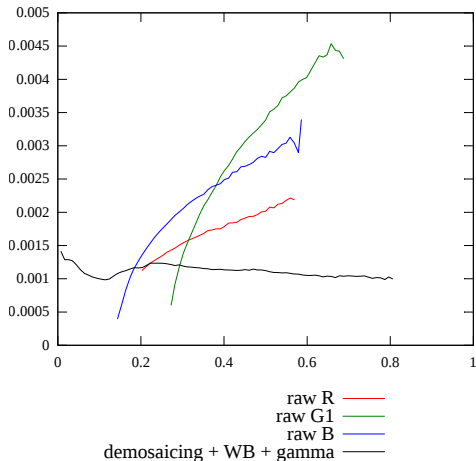
Image noise in the camera pipeline



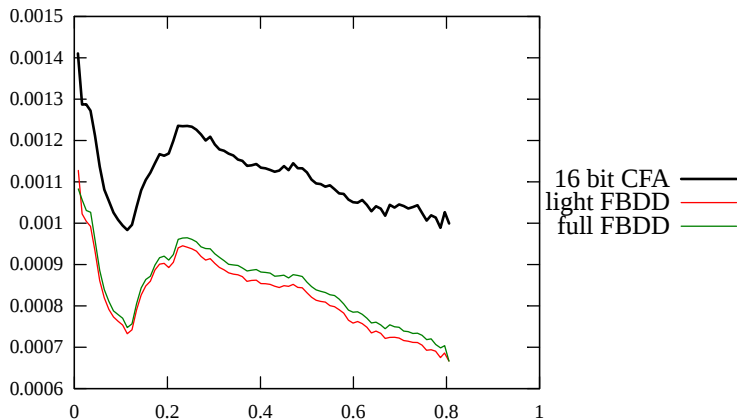
Raw images



Raw Demosaicing

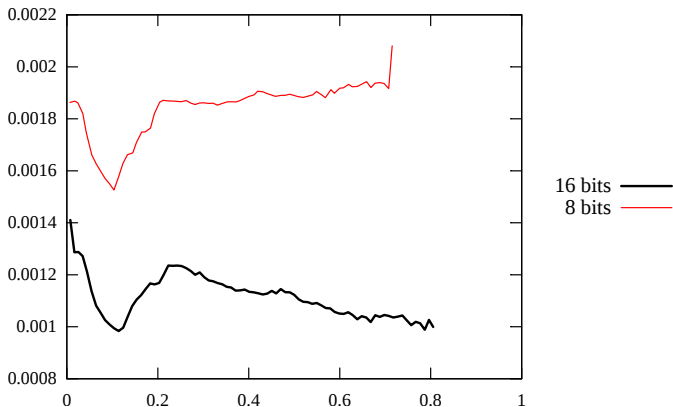


Raw Denoising



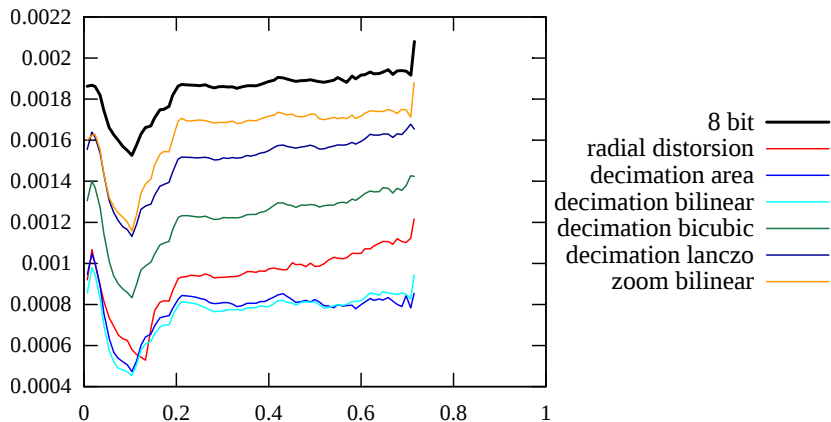
- Strength of denoising not really important

Bit Depth

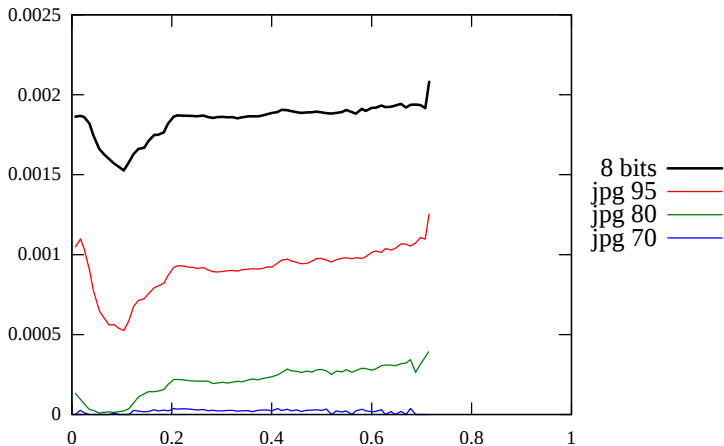


- Conversion from 10-14 to 8 bit alter the noise

Geometric operations



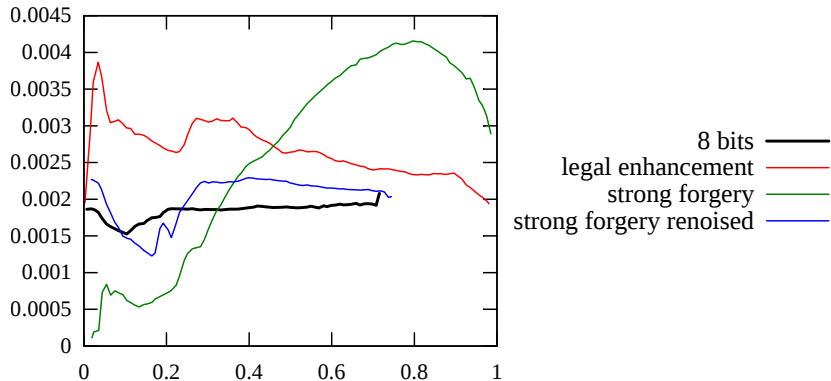
JPEG Compression



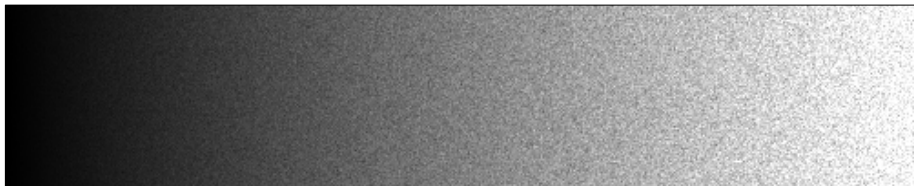
Strong forgeries



Forensics and noise

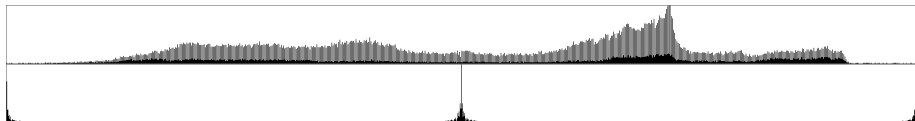


Effect of renoising on image forensics



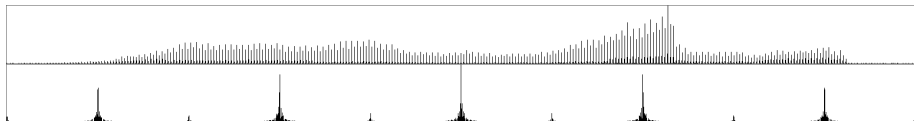
And what the falsified image is renoised?

Double JPEG



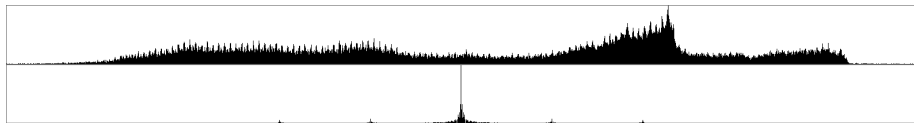
no double JPEG

Double JPEG



double JPEG

Double JPEG



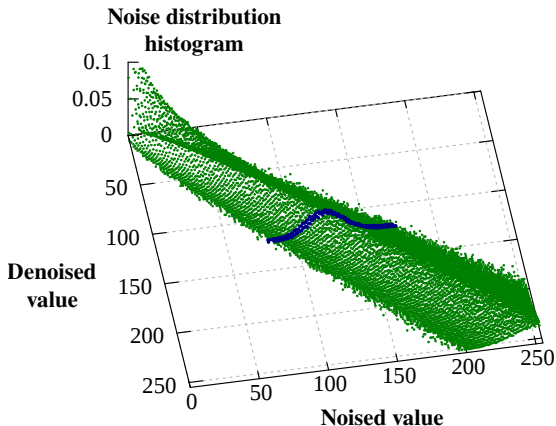
double JPEG, renoised

Noise analysis



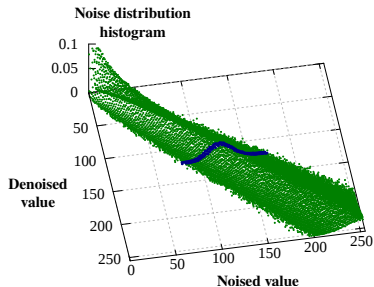
→ Best student paper award at IWDW 2015

Image noise: probability density function



- Probability density function of the noise.
- Each point (x, y) is the probability of a denoised value y having the original noised value x .

Fitting density function



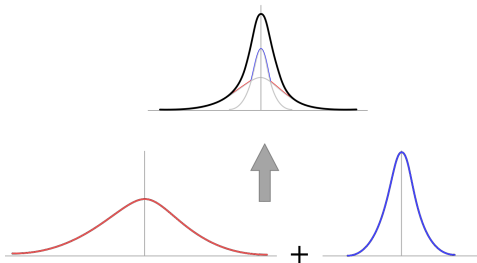
Poisson-Gauss density function:

$$f(v_d, v_n) = \frac{\alpha}{\sigma\sqrt{2\pi}} \sum_{x=0}^{\infty} \frac{(\alpha v_d)^{\alpha x} e^{-\alpha v_d}}{(\alpha x)!} \exp\left(-\frac{(v_n - x)^2}{2\sigma^2}\right)$$

Fitting:

- non-linear (but convex)
- noise inconsistency: impact on the density function not noticeable

Noise in spliced Images



- Total noise distribution = **contribution 1** + **contribution 2**
- Distinguish between the 2 spatial image contributions.

Tiling

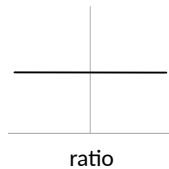
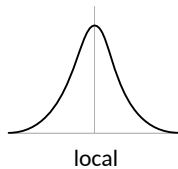
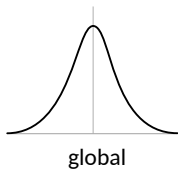


- Each tile contributes to the global noise density table:
↔ contribution table.

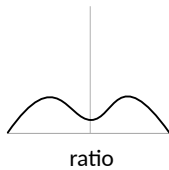
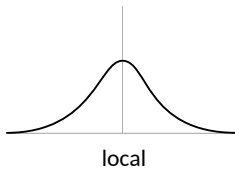
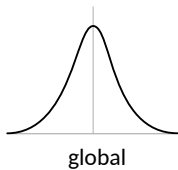
$$C_{i,j} = \frac{\text{subImage}(i, j) \text{ noise distribution}}{\text{total noise distribution}}$$

Contribution tables

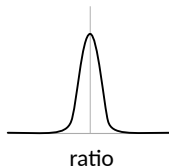
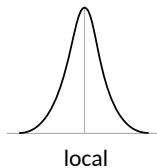
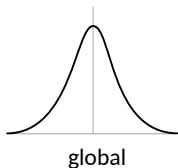
Same noise:



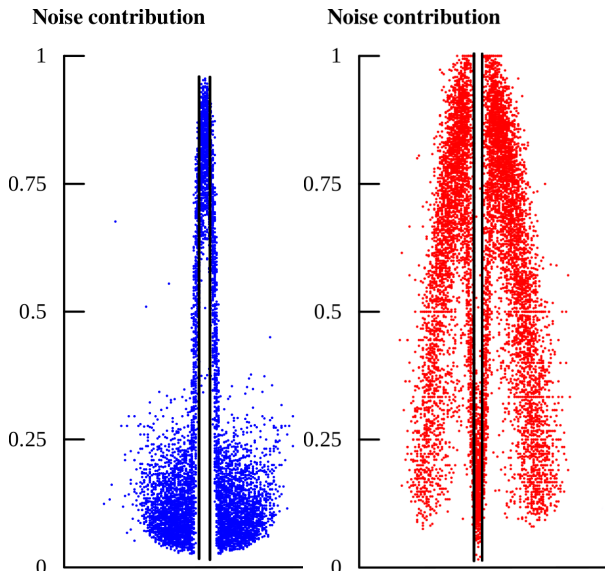
Higher noise:



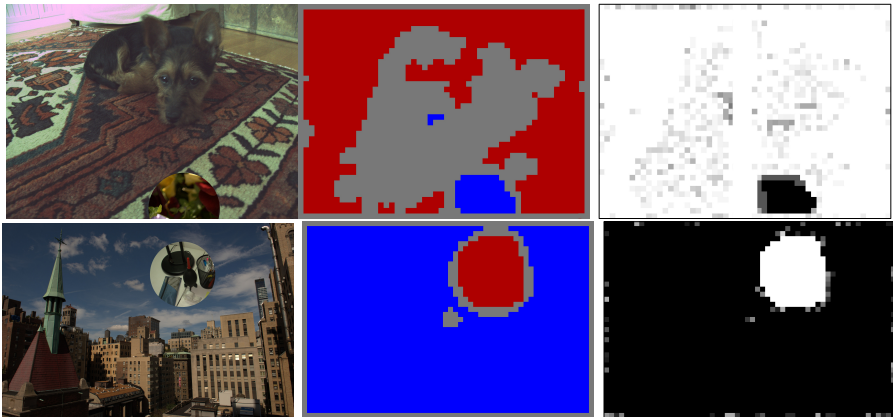
Lower noise:



Contribution tables



Results



→ Acivs 2016

Work in progress

Partner:

- Prof. Hideo Saito
- Keio University (Yagami)



Image origin



Diego Fazo

Does my image come from a camera?

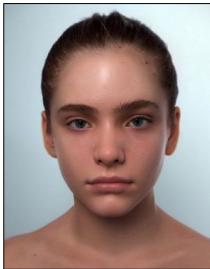
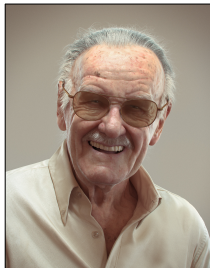
Image origin



Diego Fazo

Does my image come from a camera?

Computer graphics vs. natural images



Work in progress: identity thief detection

Source Actor



Real-time Reenactment



Target Actor



Reenactment Result



Work in progress

Partner:

- Prof. Isao Echizen
- National Institute of Informatics (NII)

↪ Identity thief detection

↪ Noise analysis



face2face, cvpr 2016

Others research interests

Geometric algebra: (conformal space)

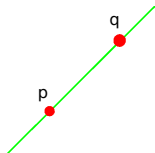


p

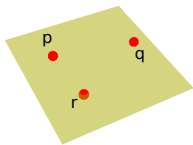
point
 \mathbf{p}



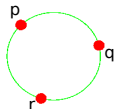
vecteur
 \mathbf{v}



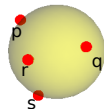
droite
 $\mathbf{l} = \mathbf{p} \wedge \mathbf{q} \wedge \mathbf{n}_\infty$



plan
 $\pi = \mathbf{p} \wedge \mathbf{q} \wedge \mathbf{r} \wedge \mathbf{n}_\infty$



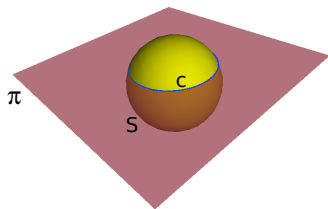
cercle
 $\mathbf{c} = \mathbf{p} \wedge \mathbf{q} \wedge \mathbf{r}$



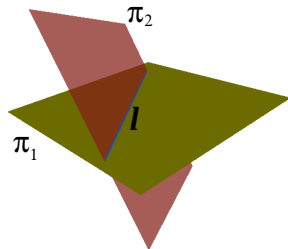
sphère
 $\mathbf{s} = \mathbf{p} \wedge \mathbf{q} \wedge \mathbf{r} \wedge \mathbf{s}$

Others research interests

Geometric algebra: (conformal space)



$$\mathbf{C} = \pi \rfloor S$$



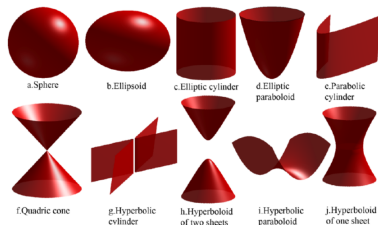
$$\mathbf{I} = \pi_1 \rfloor \pi_2$$

Work in progress

Partner:

- Prof. Akihiro Sugimoto (NII)
- Prof. Eckhard Hitzer (ICU)

- ↔ 3-conformal space
high dimensions spaces
- ↔ quadric / cubic surfaces
edition / manipulation / intersection



quadric surfaces

Work not in progress

Geometric algebra:

problem of multivector size:

n -dimension $\rightarrow 2^n$ algebra

Work not in progress

Geometric algebra:

problem of multivector size:

n -dimension $\rightarrow 2^n$ algebra

3-conformal space $\rightarrow 2^{15} \simeq 32.000$ elements algebra

Work not in progress

Geometric algebra:

problem of multivector size:

n -dimension $\rightarrow 2^n$ algebra

3-conformal space $\rightarrow 2^{15} \simeq 32.000$ elements algebra



\rightarrow quantum computers !!

Conclusion



Questions
... or lunch