Workshop

- **Forensic Image and Video Processing**

- Dallas, AAFS, 17 February 2004.

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Outline

08.30 – 09.00 Introduction by Zeno Geradts – Netherlands Forensic Institute

09.00 – 10.00 Photogrammetry by Richard Vorderbruegge PhD – FBI

10.00 – 10.20 Break

10.20 – 11.20 Image Processing by Lenny Rudin PhD - Cognitech

11.20 – 12.00 3D Techniques by Jurrien Bijhold PhD - NFI

12.00 – 12.30 Quality Assurance by Carrie Whitcomb NCFS

12.30 – 12.40 Closing remarks

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Introduction
Image processing and Video processing

Zeno Geradts

AAFS, Dallas, 2004

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Outline

- Background of this workshop
- Netherlands Forensic Institute - our group
- Investigation
- Image Restoration
- Image Comparison
- Integrity
- Image processing on fingerprints

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Background

- 1994 Special conference by Scotland Yard on Forensic Image and Video Processing
  Lenny Rudin / Simon Bramble
- SPIE Investigative Image Processing www.spie.org conference from 1995
- 2000 : estabishing a working group within SPIE – chairmen Lenny Rudin / Zeno Geradts
- Several conferences until 2003

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Mission

- Facilitating an open communication between scientists, industry and law enforcement in the field of forensic image processing and pattern recognition.

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Netherlands Forensic Institute

- Arnout Ruifrok PhD, Ivo Alberink PhD, Jurrien Bijhold PhD, Mirelle Goos MS, Bart Hoogeboom MS, Derk Vrijdag BS, Zeno Geradts PhD

- Group Image Investigation and Biometrics of Digital Evidence Department

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Group Image Investigation and Biometrics

- Image Integrity
- Camera identification
- Research on video techniques
- Image Restoration
- Interpretation in 3D-models
  - bullet trajectory analysis
  - Length measurement
  - 3D-visualisation
- Morphometric comparison with 3D images
- Face comparison
- FearID project
- Biometric systems
- Pattern Recognition from Forensic Image Databases

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Investigation

- CCTV images (often time lapse)
  - Accidents, robberies
  - Typical problems : low quality

- Video from handycams
  - Accidents, disasters, snuff-movies, from the police
  - typical problems : moving camera / zooming

- Photo material
  - from police, child pornography, identity-documents

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Typical Questions

- Has there been tampered with the images
- Image enhancement
- Velocity of a car from video images
- Is the person on the CCTV-images the same as a suspect

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Video of CCTV-systems

Many CCTV everywhere. 2000-2004 : Explosive growth of number of camera's sold. For example the Rijksmuseum and Van Goghmuseum will have 700 cameras.

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Example Image Processing

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Original

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DE-INTERLACED

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DEBLURRING

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Magnification

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Super resolution

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Example

Example – bad results

Image Processing license plates ???

25-07-00 TUE
08:11:00

autos-divx.avi

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Surveillance video tapes

characteristics

- View of large space or door, no close-ups
- Time-lapse, typical 4 images per second
- Multiplex recording, typical 4 to 12 cameras
- Digital Systems

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Difference Day and Night

25-06-99 72H
21 11 13

25-06-99 72H
22 45 59

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Digitization: equipment

- a number of high end and home video players
- Digital equipment
- Uncompressed digitizing for example with commercial software
  - or
- Media analysis

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DVD / CD-recordable contains:

CD-recordable contains:
- processed image or small movie files
- instructions for viewing
- compressed movie-files for reference purposes (annotation of image sequence number)
- table of hash-codes
- a hash-code for the table is given in a written report

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References of Images

Video overlays of reference points
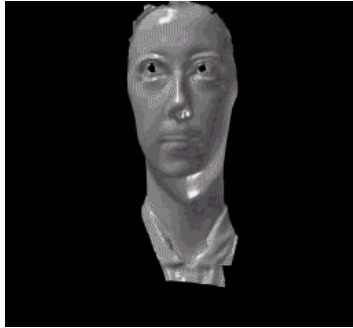
Measuring the length

- lens distortion

  objects with straight edges in the image

- perspective projection

  point like objects in the image

- upper and lower limits for length

  propagation of estimation errors

  use of prior knowledge

Match of scene with image
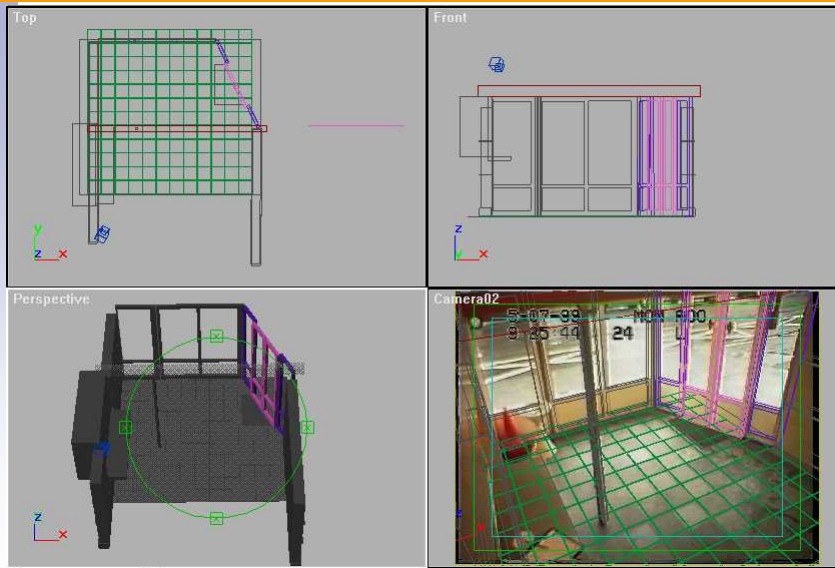
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Match of biped with a person

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Surveillance video and animation

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Gait parameters

Experiment by Menno Merlijn, student

Free university Amsterdam

• 12 persons walk 5 times with markers
• 3 camera's: top view, frontal view and left view
• analysis of pixel positions of markers

Most characteristic parameters:
• angle between foot and walking direction
• step length

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Methods

- (1) defects in CCDs
- (2) compensation for these errors in the camera's
- (3) file formats that are used
- (4) noise introduced by the CCD
- (5) watermarking

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Authenticity

- Research together with Naoki Saitoh from the National Research Institute of Police Science in Tokyo

Defects
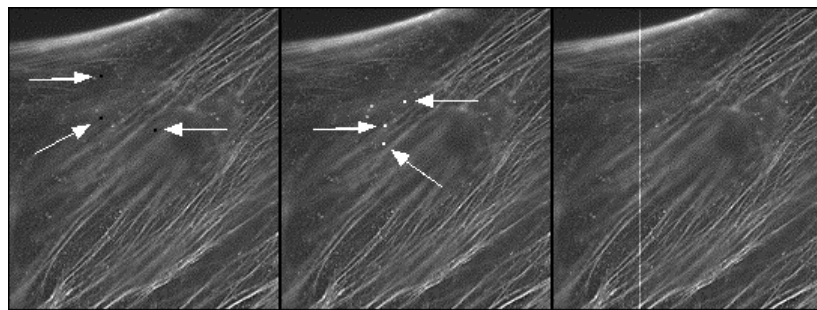
Cold pixel   Hot pixel   Column defect
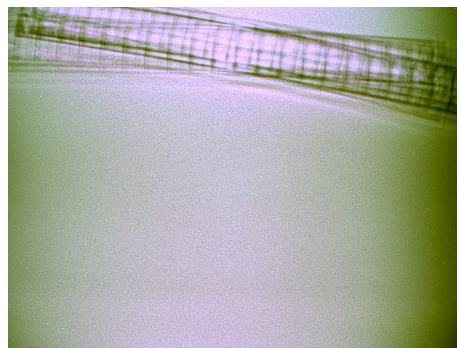
Experiments with Trust Camera's

- Dark images

Movie　　　　　　　Still Image

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Average Number of Images

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Camera Comparison (movies)

Camera 1   Camera 2

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Temperature influence

0 C   20 C
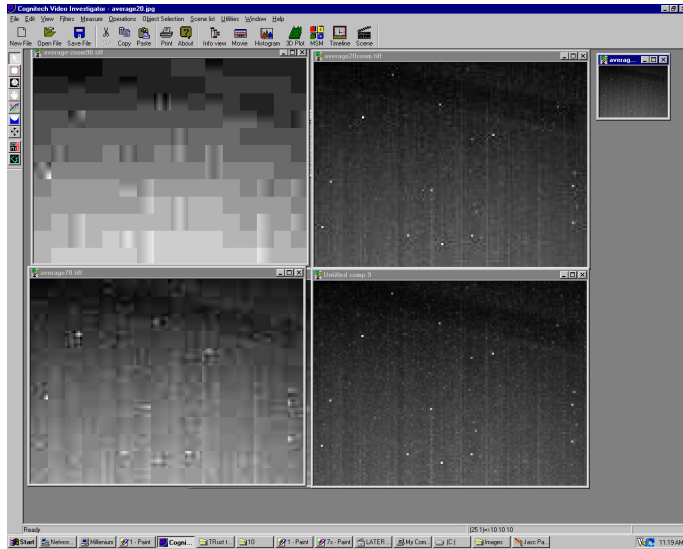

40 C

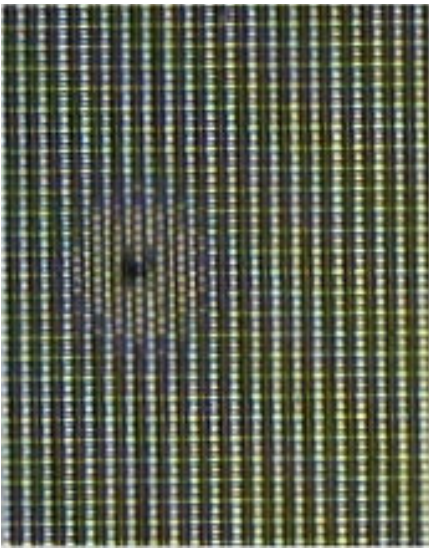*Justitie* Nederlands Forensisch Instituut

Compression

CCD pixel defects

Other camera's tested

Sony Mavica

Sony Cybershot

Sony FD83

Sony DV Handycam

No visible pixel defects detected. For these
camera's more sophisticated methods are
needed.

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Several times used in case work

- Child pornography images with pixel defects
- Determine if the defects are random !

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File Headers

- JPEG
- JFIF
- EXIF
- CIFF
- SPIFF
- FLASPIX
- CAM
- APP12
- TIFF
- ….. Investigate serial numbers etc.

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Media

- CompactFlash
- SmartMedia
- Miniature Cards
- PCMCIA-kaarten
- …

Investigate the serial numbers in these cards

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Conclusion

- Pixel defects can be found in images with camera's
- It is important to know how random these defects are
- This method can be used for cheap camera's.

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Image Integrity

- Has there been tampered with this image ?

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Image Processing of finger prints

Zeno Geradts, Arnout Ruifrok,
Jos van Wouw, Jitteke Struik

Netherlands Forensic Institute

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Validation of image processing

- Several publications in forensic journals and publications from 1988
- Actual work in fingerprints, documents, video image processing
- SPIE working group Investigative Image Processing
- US – Frye / Daubert

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A.L. McRoberts, "Digital Image Processing as a Means of Enhancing Latent Fingerprints", Proceedings of the International Forensic Symposium on Latent Prints, FBI July 7-10, 1987, 165-1666.

- "Often, the initial reaction is one of disapproval. The concern is that non-existent detail is added to the latent print. Image enhancement techniques are not designed to create detail but to improve images for human interpretation.
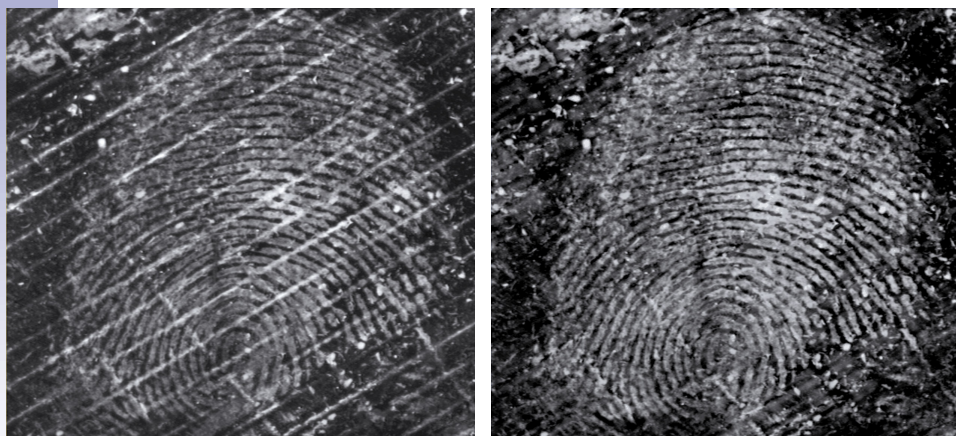
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continued

- Just as photographic techniques assist us in seeing various spectral ranges (such as infrared) and microscopes help us to see extremely small items, image enhancement techniques can help us to discern minute details within the image."
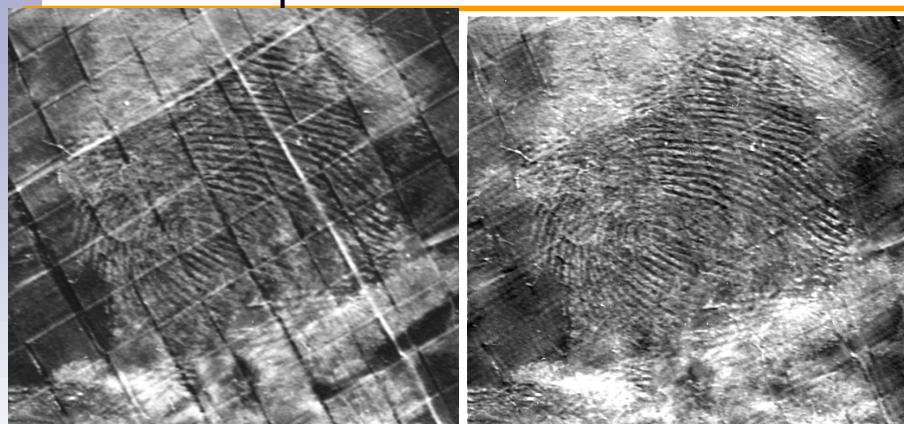
Methods

- Contrast stretching / histogram equalization – low risk

- use of kernels - depending on kernel risk

- FFT – higher risk

- Dilation / erosion – high risk

- Wavelet – unknown risk

- Subtraction with registration (Improofs project EU) – depending on method used
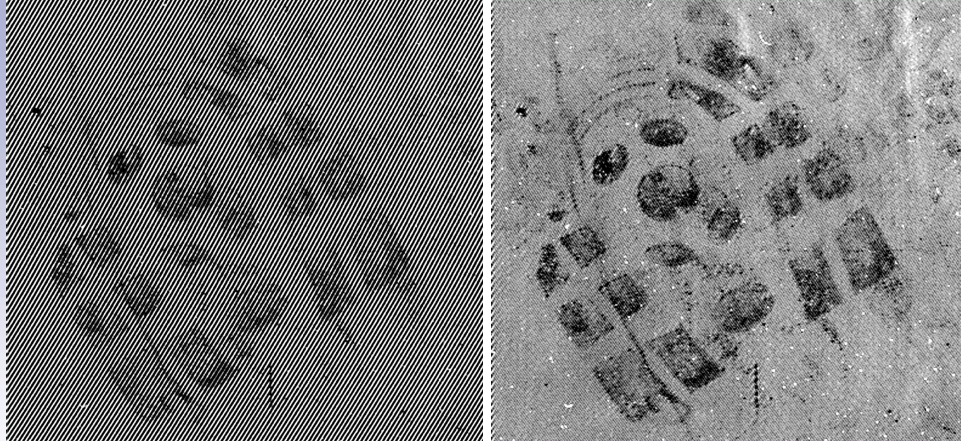
FFT example

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FFT example 2

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FFT shoeprint

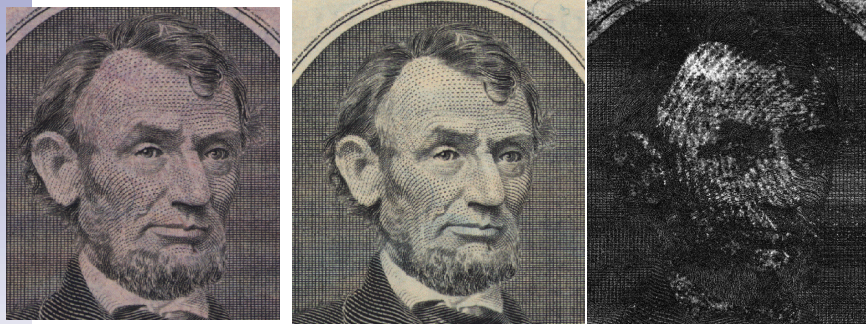*Justitie* Nederlands Forensisch Instituut

Warnings

- 1994 S. Bramble : "We found that excessive cutting of the data can seriously degrade the image". And in

- 1993 E. Berg : "However, one must be extremely careful when using the FFT spike boost so as not to cross the line between enhancement and restoration".

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Feb. 1998 STATE v. HAYDEN 109 90

- "The evidence in the record supports the trial court's unchallenged findings that the technique utilised by Berg has a reliability factor of 100 percent and a zero percent margin of error and that the results are visually verifiable and could be easily duplicated by another expert using his or her own digital camera and appropriate computer software."

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Subtraction - Improofs

http://www.esat.kuleuven.ac.be/~konijn/improofs.html

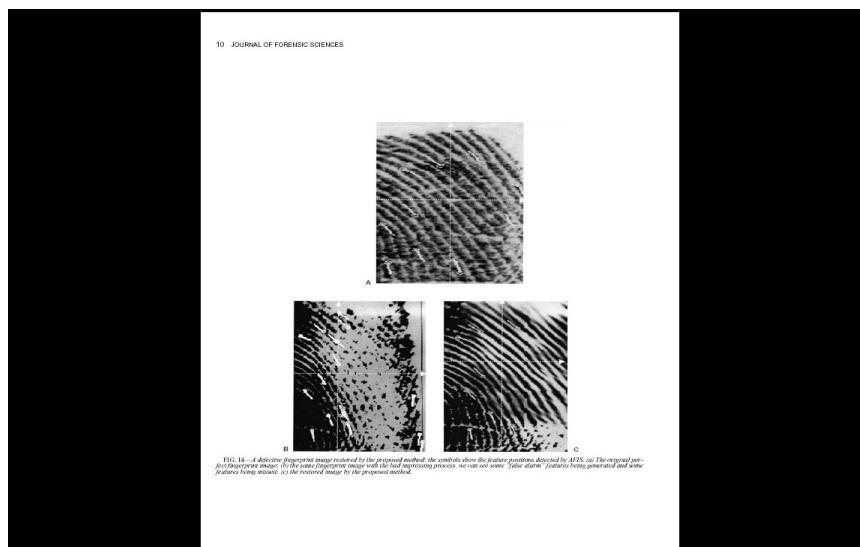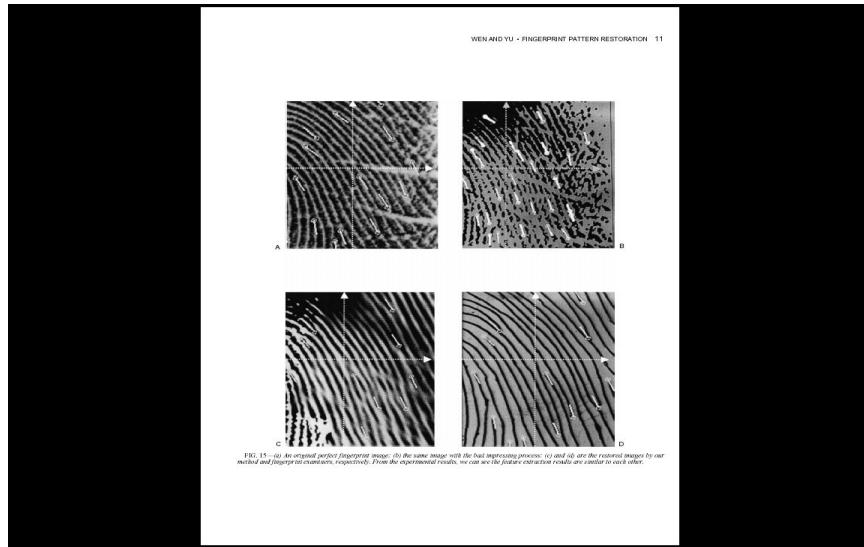*Justitie* Nederlands Forensisch Instituut

New techniques

- Che-en Wen ; Journal of Forensic Science September 2003 pp. 1-12.
- Tests on synthetic fingerprints
- AM-FM method - similar to wavelet filtering

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Example from JOFS

FIG. 14—A defective fingerprint image restored by the proposed method; the symbols show the feature positions detected by AFIS. (a) The original perfect fingerprint image; (b) the same fingerprint image with the bad impressing process, we can see some "false alarm" features being generated and some features being missed; (c) the restored image by the proposed method.

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FIG. 15—(a) An original perfect fingerprint image; (b) the same image with the bad impressing process; (c) and (d) are the restored images by our method and fingerprint examiners, respectively. From the experimental results, we can see the feature extraction results are similar to each other.

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Discussion

- Which new technique are admissible
- If critical reviewed, can the current techniques also lead to discussion in court ?
- Know what the limits are of image processing
- Validation with same method as is used for the WSQ-compression ? - test with different examiners (proficiency testing)
- Depending on the number of features that are visible

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Questions?

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