Progressive and interactive modes of image transmission: optimized wavelet-based image representation

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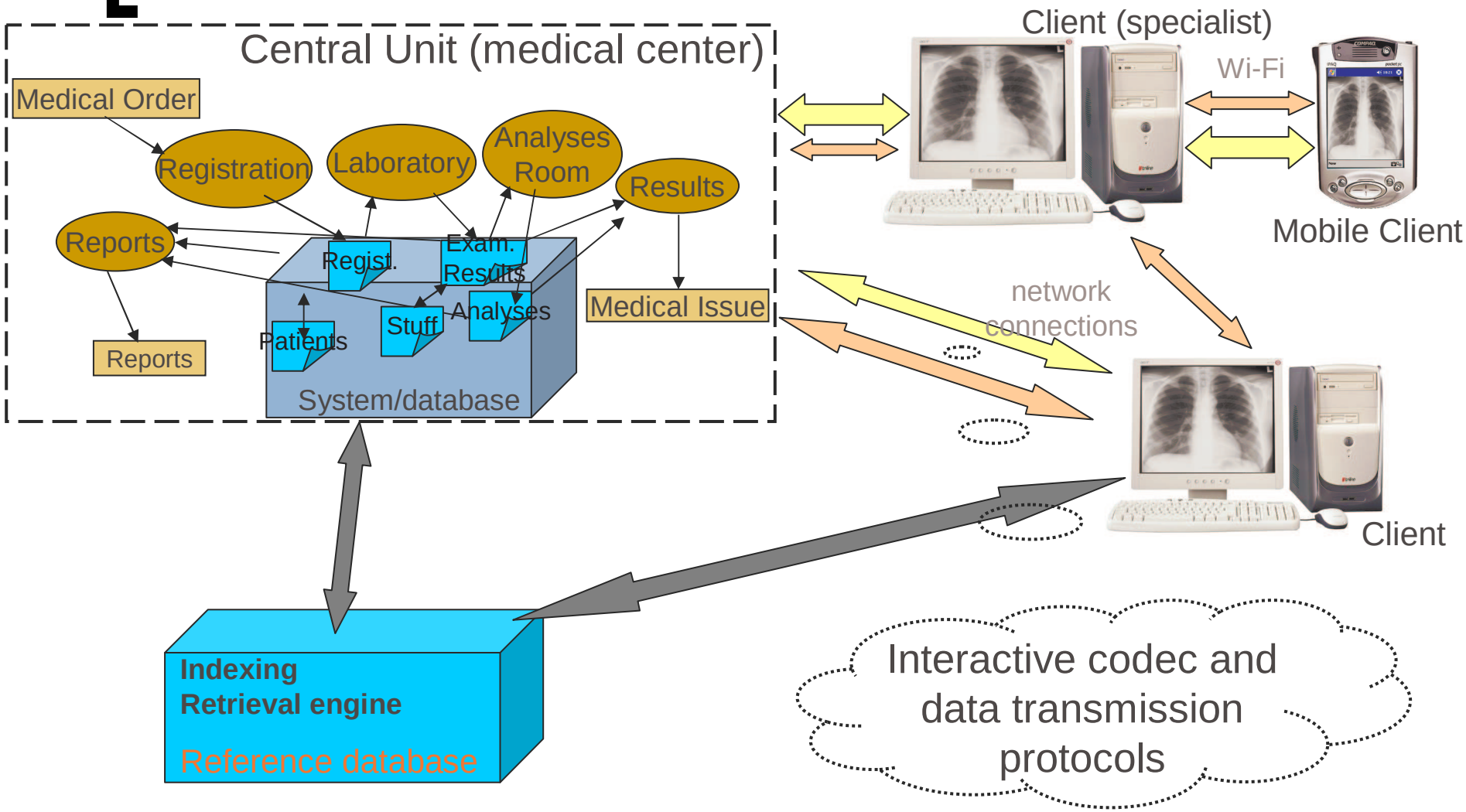
Outline

- Context: Teleinformation medical system (PACS-RIS-telediagnosis-reference database)
- Props1: Interactive progression (user interface)
- Props2: Image indexing (reference database)
- Props3: JPEG2000 as medical (teleradiology) standard
- Props4: Faster encoder (archiving and transmission)
- Props5: Effective encoder (optimized)
- Conclusions (use it!)

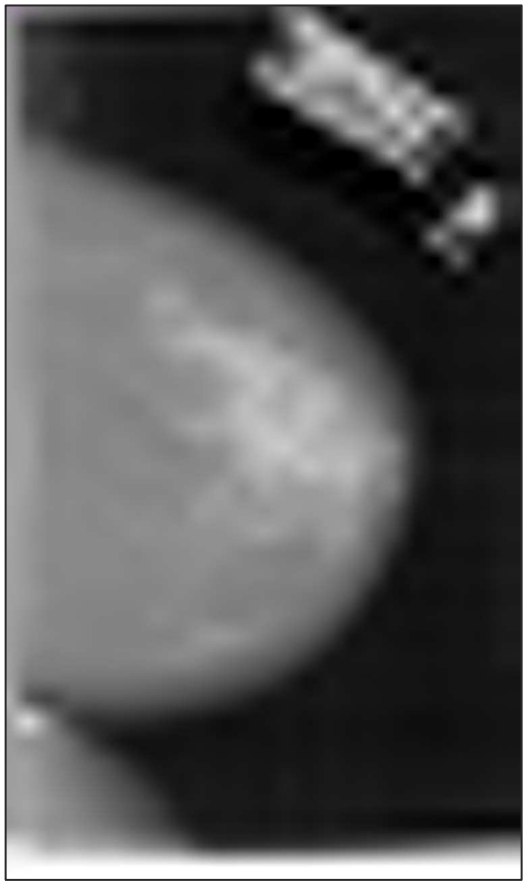
Context: Teleinformation Radiology System



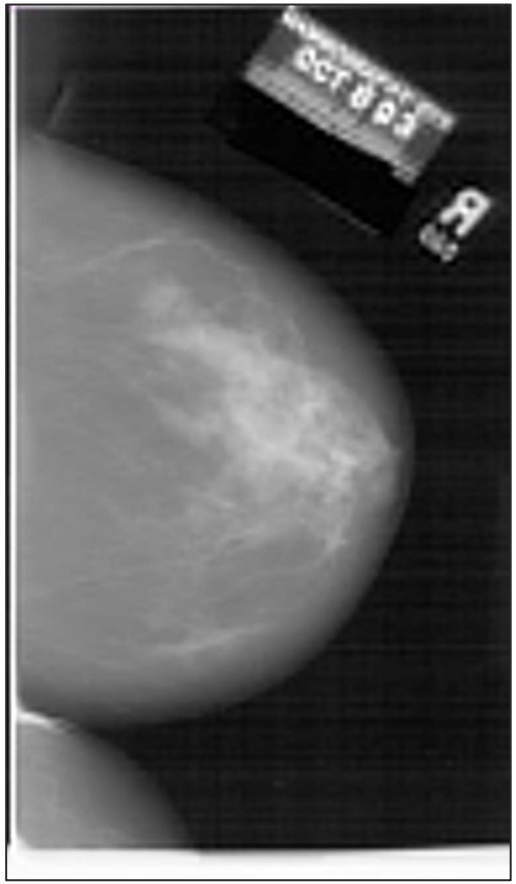
Progressive Interactive Internet Codec

- Teleconsultings and picture sharing with other system clients
- Multi-platform, system independent architecture
- Progression modes
- Region of interest (ROI) progression
- Interactive protocols
- Inteligent User Interface

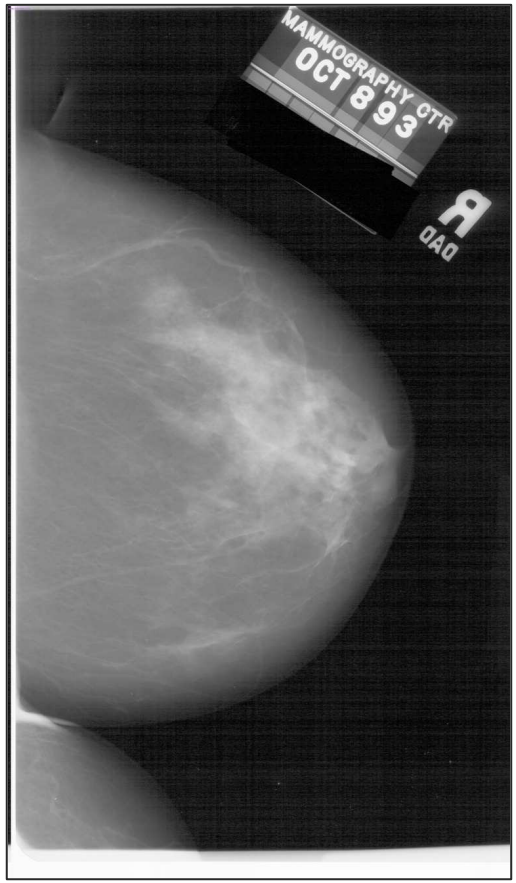
Progressive image data stream decoding



After 0.5%



After 2%



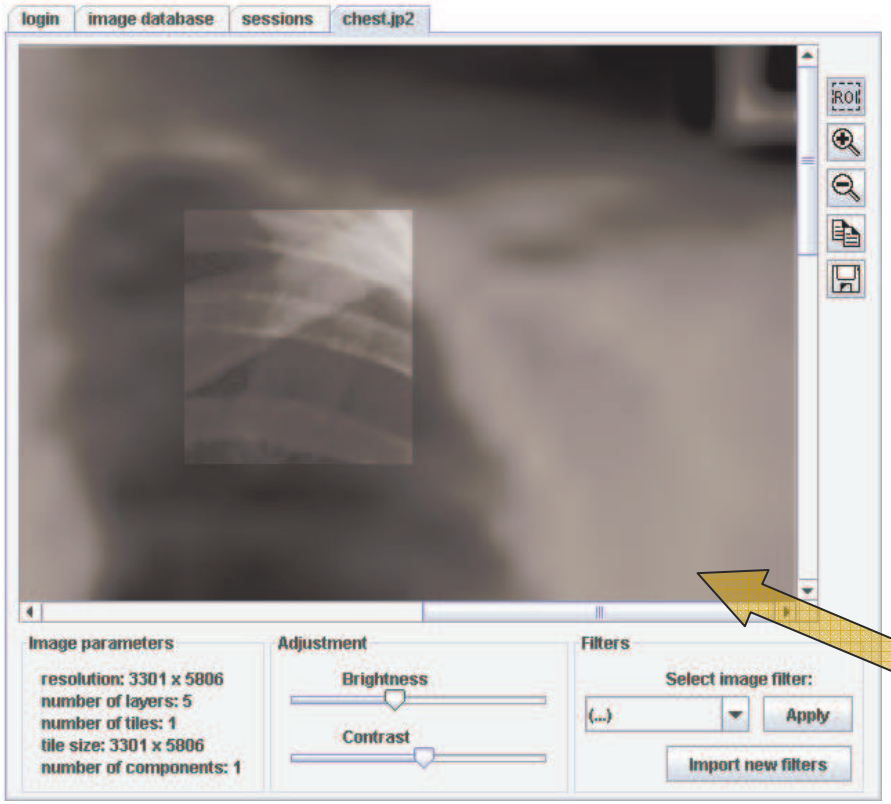
After 100%

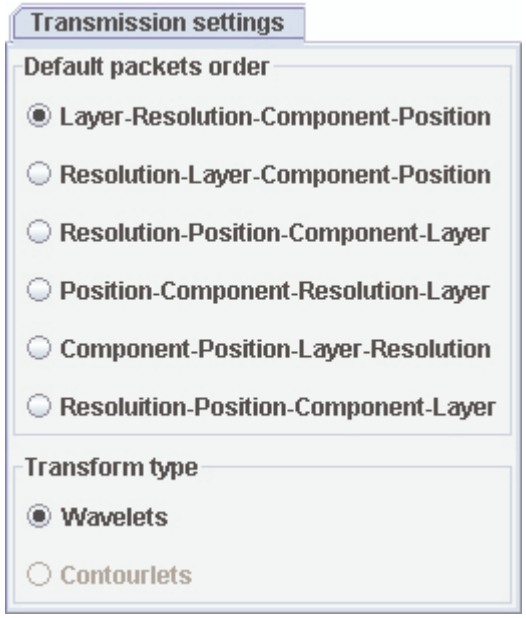
Slajd 5

H1

Progressive image data stream decoding significally increases effectiveness of large image transmission via low or medium-speed internet connection. It enables image character and content analyze just after few percents of downloaded data bytes.
These 3 pictures contain the same image reconstructed using respectively 0.5, 2 and 100% of image data bytes.
Currently I have been working at using of conturlets instead of wavelets which are expected to be more efficient
Hałasa; 2005-10-21

Interactive image exchange (JPEG2000 data stream)





selected ROI

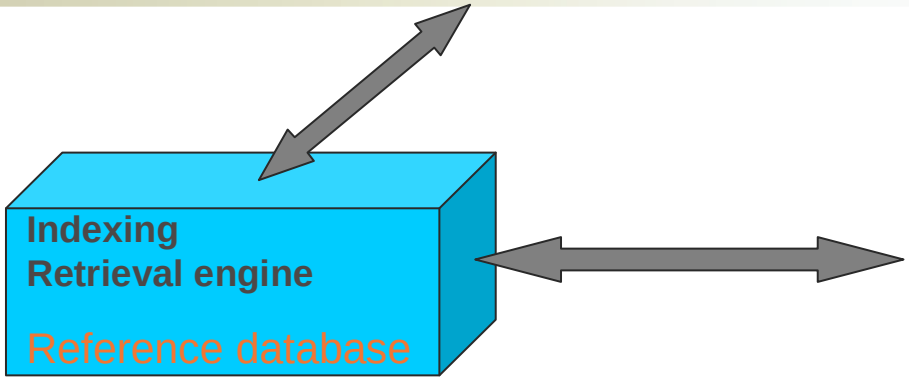
Simple image transmission protocol (SITP) = flexible XML-based control connection + high performance image stream via UDP

Slajd 6

H2 Progressive image data decoding may be even more efficient when used with Region of Interest selection.
Selecting the ROI affects on coding blocks sequence in image stream and enables desired area to be reconstructed in the first order

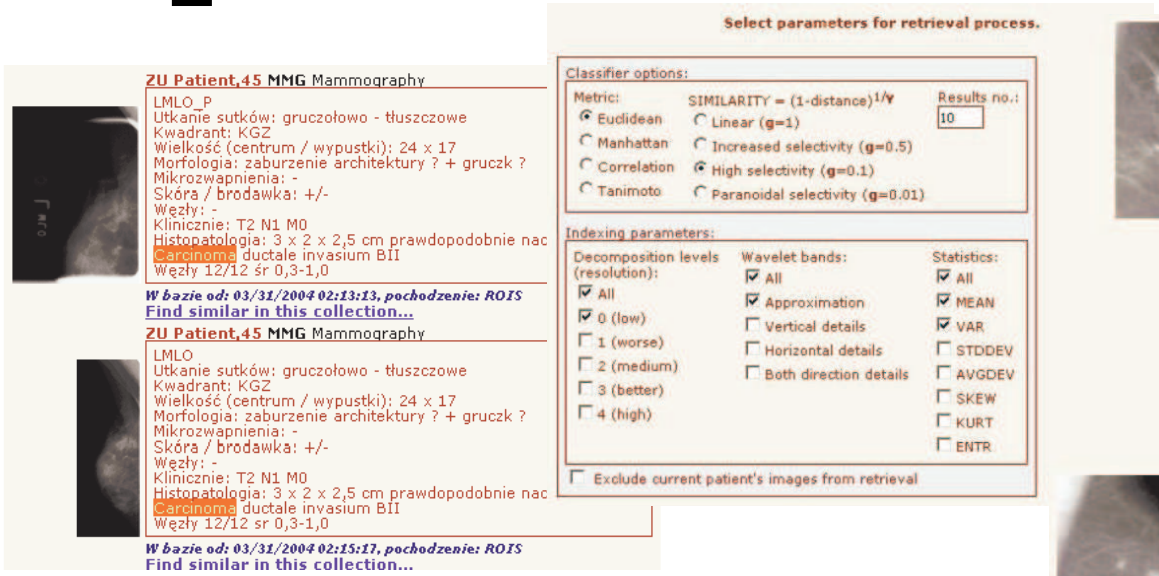
Hałasa; 2005-10-21

Image database indexing and retrieval



- Reference diagnostic database
- Index in wavelet domain
- User Boxes (JPEG2000 data stream)
- Fast and precise retrieval
- Web access

Reference database



Precision:

Images	Profiles		
	Manhattan, Var, HH, max n	Correlaction, ADev, HL, max n	Tanimoto, Var, LH, max n
CT	**84%**		
MR		**80%**	
MMG			**76%**

JPEG2000 is medical standard? YES

DICOM:

- it allows transmission of images with improving resolution and quality, which will be extremely useful in teleradiology and in some PACS network environments

JPEG2000 is medical standard? NO: irreversible compression

- scientific community has not come to a consensus
- fear: valuable information might be lost through compression
- DICOM does not, and will never, “approve” compression schemes for any particular use

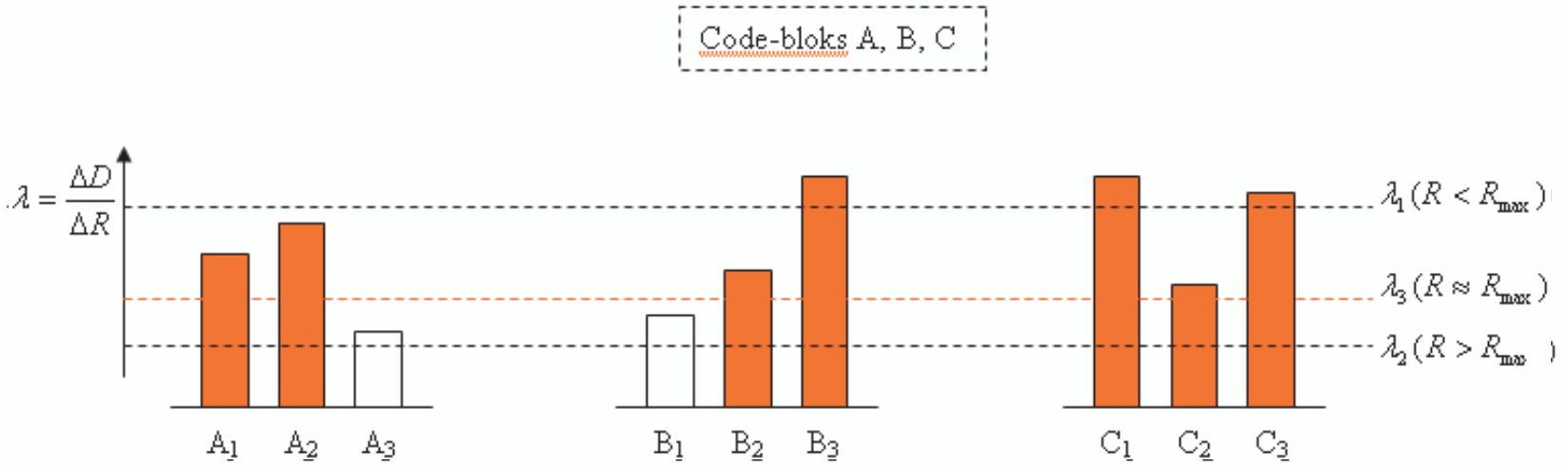
JPEG2000 is medical standard? YES

- „avoiding all risks is the risk ”
- DICOM: professionals make decision and take responsibility
- Litigation risks: regulators rely on the professions to lead the way

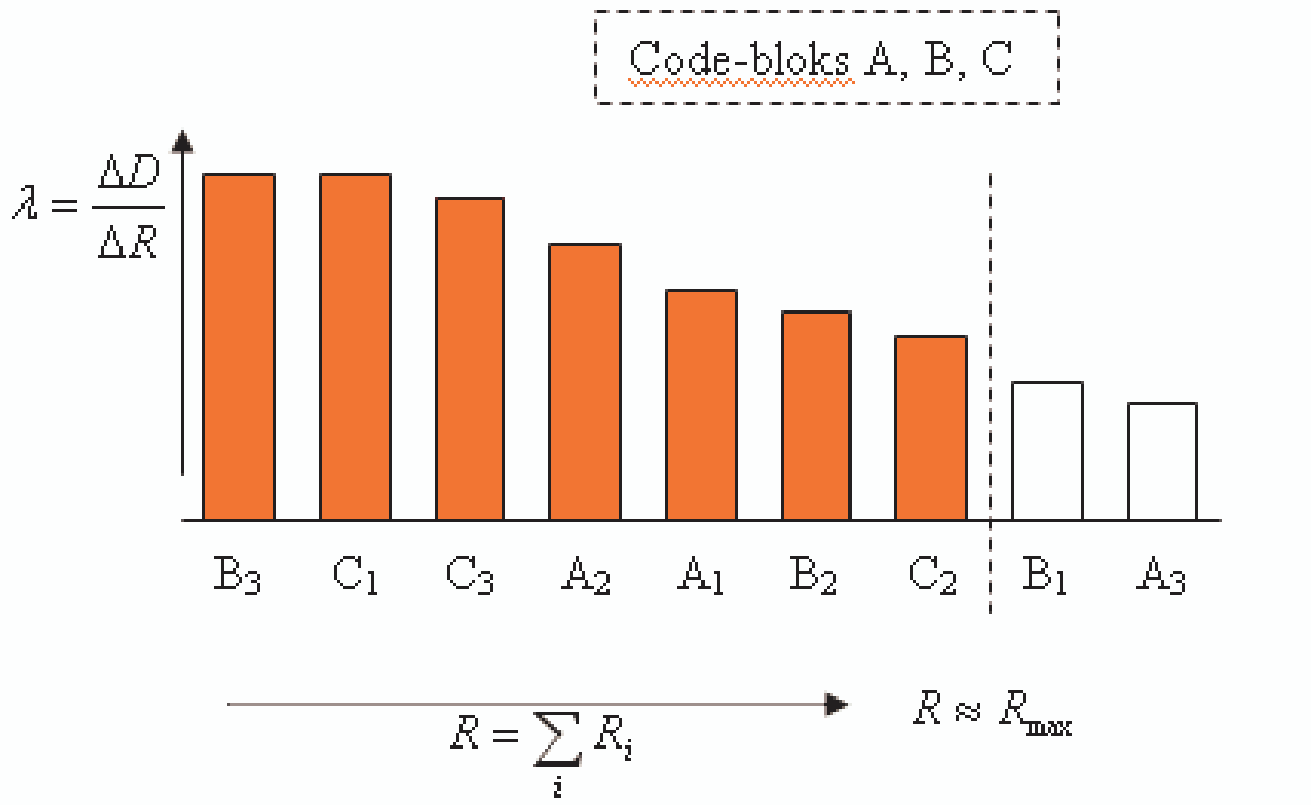
Faster JPEG2000 encoder

- Optimized PCRD: improvement of Jasper C implementation (JPER)
- Solution: Sorting instead of iterative bisection
- Effect: multi-layers coding without additional time costs
- Faster archiving and transmition (reduced time costs, reduced memory costs, simplicity)

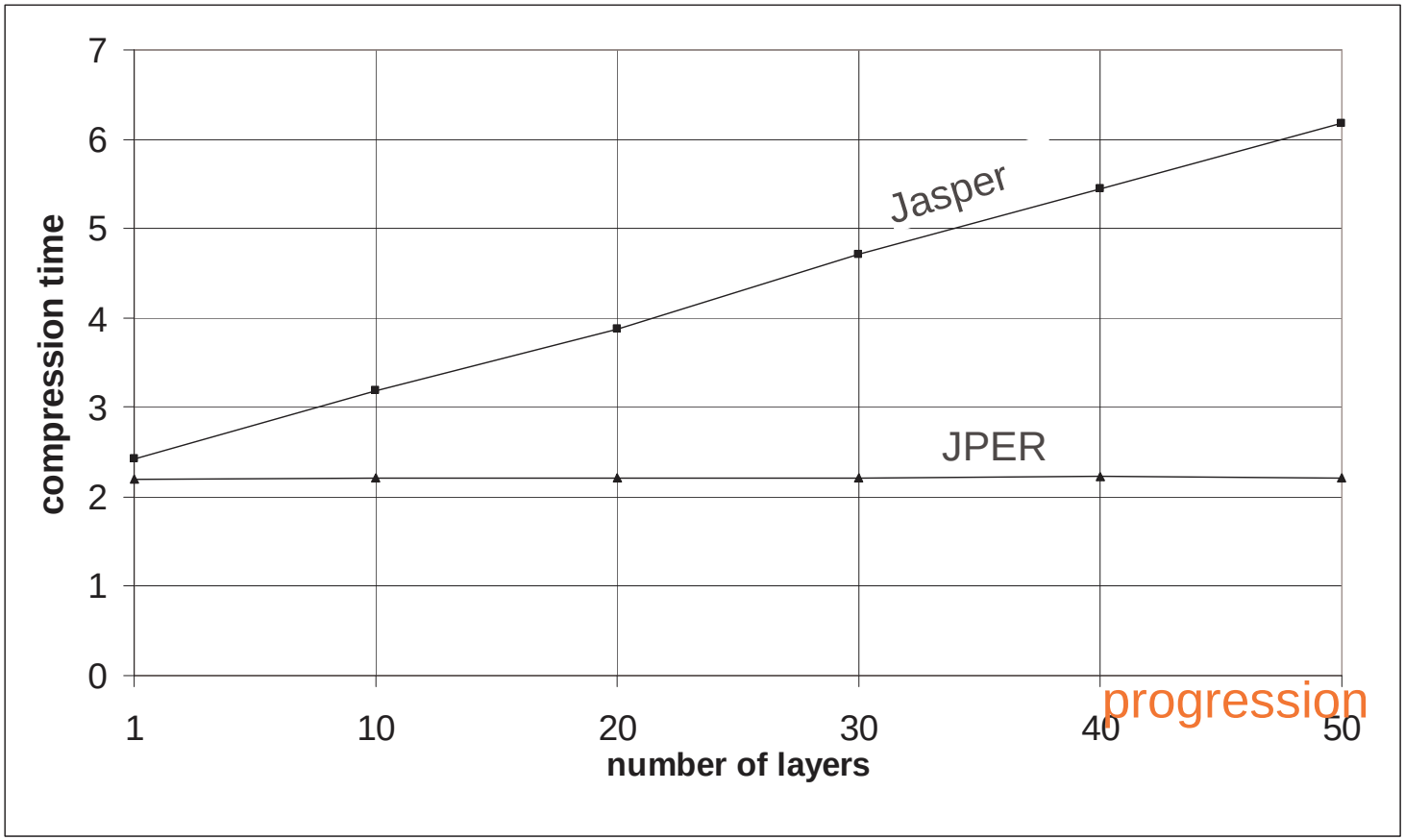
Basic idea of PCRD in Jasper



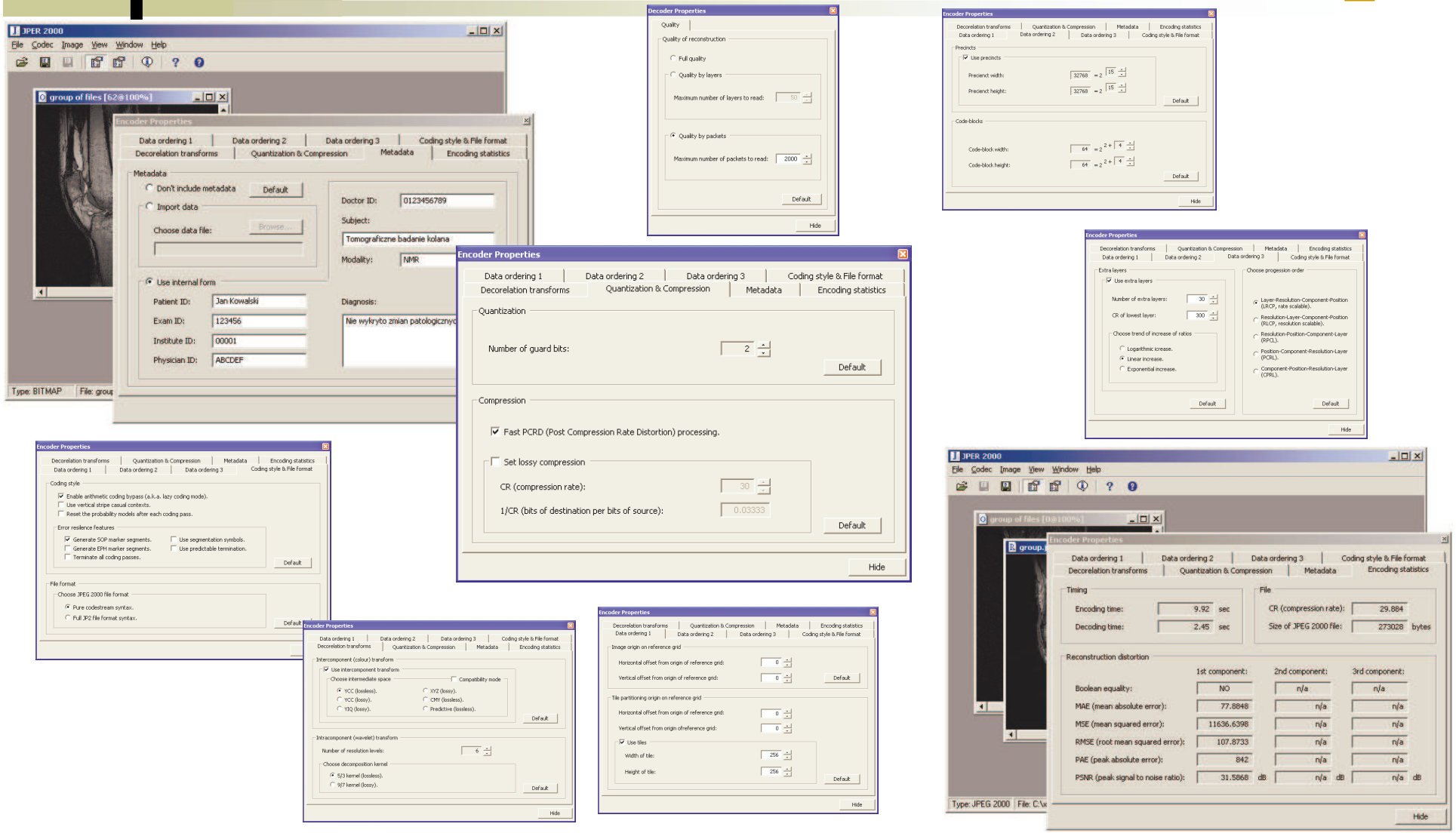
Basic idea of PCRD in JPER



Experimental Effects



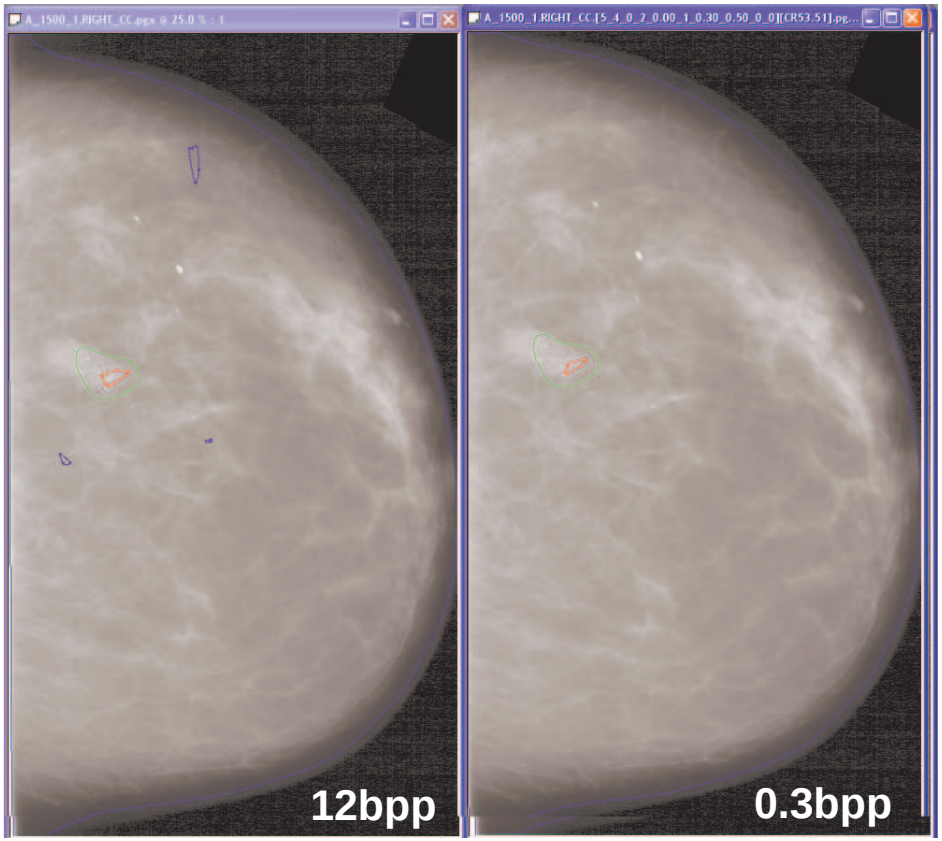
JPER2000


JPER 2000
File Codec Image View Window Help
group of files [62@100%]
Encoder Properties
Data ordering 1
Data ordering 2
Data ordering 3
Coding style & File format
Decorelation transforms
Quantization & Compression
Metadata
Encoding statistics
Metadata
Don't include metadata
Default
Import data
Choose data file:
Browse...
Use internal form
Patient ID:
Jan Kowalski
Exam ID:
123456
Institute ID:
00001
Physician ID:
ABCDEF
Doctor ID:
0123456789
Subject:
Tomograficzne badanie kolana
Modality:
NMR
Diagnosis:
Nie wykryto zmian patologicznyc
Type: BITMAP
File: grou
Decoder Properties
Quality
Quality of reconstruction
Full quality
Quality by layers
Maximum number of layers to read:
Quality by packets
Maximum number of packets to read:
2000
Default
Hide
Encoder Properties
Precincts
Use precincts
Precinct width:
Precinct height:
Code-blocks
Code-block width:
Code-block height:
Default
Hide
Encoder Properties
Data ordering 1
Data ordering 2
Data ordering 3
Coding style & File format
Decorelation transforms
Quantization & Compression
Metadata
Encoding statistics
Quantization
Number of guard bits:
2
Default
Compression
Fast PCRD (Post Compression Rate Distortion) processing.
Set lossy compression
CR (compression rate):
30
1/CR (bits of destination per bits of source):
0.03333
Default
Hide
Encoder Properties
Extra layers
Use extra layers
Number of extra layers:
30
CR of lowest layer:
300
Choose trend of increase of ratios
Logarithmic increase.
Linear increase.
Exponential increase.
Choose progression order
Default
Hide
Encoder Properties
Coding style
Enable arithmetic coding bypass (a.k.a. lazy coding mode).
Use vertical stripe casual contexts.
Reset the probability models after each coding pass.
Error resilence features
Generate SOP marker segments.
Generate EPH marker segments.
Terminate all coding passes.
Use segmentation symbols.
Use predictable termination.
Default
File format
Choose JPEG 2000 file format
Pure codestream syntax.
Full JP2 file format syntax.
Default
Encoder Properties
Intercomponent (colour) transform
Use intercomponent transform
Choose intermediate space
Compatibility mode
YCC (lossless).
YCC (lossy).
YIQ (lossy).
XYZ (lossy).
CMY (lossless).
Predictive (lossless).
Default
Intracomponent (wavelet) transform
Number of resolution levels:
6
Choose decomposition kernel
5/3 kernel (lossless).
9/7 kernel (lossy).
Default
Hide
Encoder Properties
Image origin on reference grid
Horizontal offset from origin of reference grid:
Vertical offset from origin of reference grid:
Default
Tile partitioning origin on reference grid
Horizontal offset from origin of reference grid:
Vertical offset from origin ofreference grid:
Use tiles
Width of tile:
Height of tile:
256
Default
Hide
JPER 2000
File Codec Image View Window Help
Encoder Properties
Timing
Encoding time:
9.92
sec
Decoding time:
2.45
sec
File
CR (compression rate):
29.884
Size of JPEG 2000 file:
273028
bytes
Reconstruction distortion
1st component:
2nd component:
3rd component:
Boolean equality:
NO
n/a
n/a
MAE (mean absolute error):
77.8848
n/a
n/a
MSE (mean squared error):
11636.6398
n/a
n/a
RMSE (root mean squared error):
107.8733
n/a
n/a
PAE (peak absolute error):
842
n/a
n/a
PSNR (peak signal to noise ratio):
31.5868
dB
n/a
dB
n/a
dB
Hide
Type: JPEG 2000

Increased compression efficiency

- Reduced bit rates
- Selective compression: diagnostic quality progression
- Profiles (e.g. for mammograms: 17/11 filter bank, 8 levels of diadic, nz=0.6, layer progression, code-blocks 64x64)

The results: diagnosis based on JPEG2000 compressed images

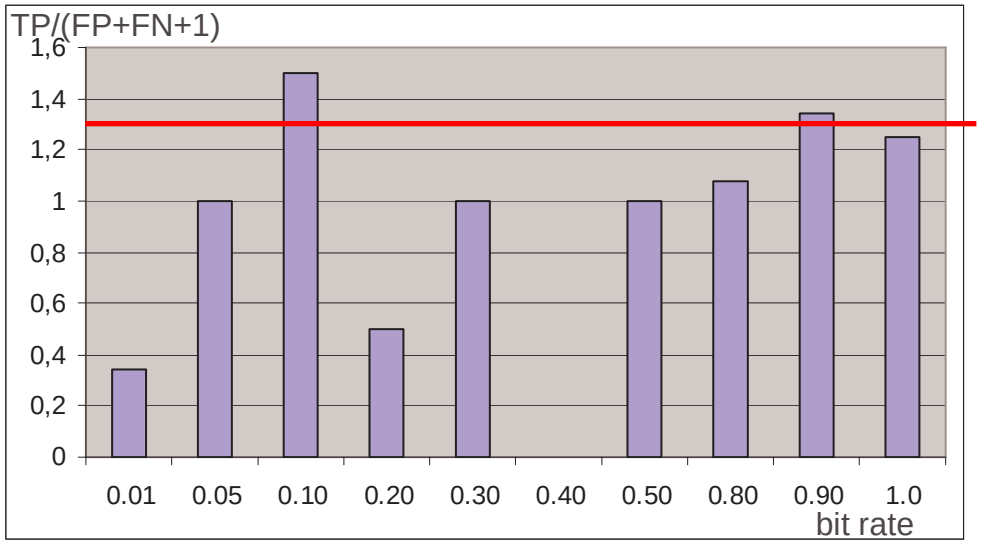


mammograms

Quality subjectively: 1bpp

ROC-based detection: 0.1bpp

CAD: 0.9bpp



Conclusions

- JPEG2000 is flexible enough for telediagnosis (teleradiology)
- Implemented improvements enhanced information exchange
- Clinical experiment are required to verify our complex system
- Please, use it! It works!