



# Modern methods of increasing the information capacity of digital images

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# Contents

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- Project description
- The goal of the presentation
- Main requirements for the methods
- Modern methods overview
- Image models overview
- Conclusions
- Future research plans



# Project description

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## **Increasing the information capacity of digital images in telecommunication systems**

- Nowadays a lot of digital images are used in different areas of life (at home, at work etc.).
- In many cases we need to have additional information about our images (information about author, time, places, etc.).
- It important to add such additional information while creating digital images.
- Part of this information may be obtained automatically (for example by mobile device: place - by GPS; time-by onboard clock, etc.), and other part could be added by user.
- It is possible to add this information using statistical and psychophysical redundancy of digital images.



# The goal of the presentation

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- To make an overview of the modern methods of increasing Information Capacity and Image Models
- To show the way for more efficient increasing the Information Capacity of Digital Images
- To show the future research approaches



# Main requirements for the methods of Increasing Information Capacity

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- The method should:
  - add as much additional information as possible;
  - minimize increasing of resulting image size;
  - fast algorithms for Adding, Searching and Extracting of information;
  - ensure stable data storing;
  - add the information while creating digital image on device.
- The method shouldn't decrease visual quality of initial image.



# Modern methods overview

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- Formatted – the possibility of information adding is defined by image file format:
  - By using format field specified for special type information
  - By using format fields that are not specified for special type information
  - By using additional extensions
- Unformatted - the possibility of information adding is defined by digital image redundancy:
  - By adding information in time domain
  - By adding information in spectrum domain



# Modern methods overview

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- Formatted methods examples:
  - EXIF (Exchangeable Image File Format)
  - GIF (Graphics Interchange Format)
  - TIFF (GeoTIFF)
- Unformatted methods examples:
  - By adding information in time domain:
    - LSB methods
  - By adding information in spectrum domain:
    - DCT methods
    - DWT methods



# Modern methods overview

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- Formatted methods:
  - Main advantages:
    - Fast algorithms of adding and extracting additional information.
    - Is not limited by the level of redundancy (independent on image type).
  - Main disadvantages:
    - Lost of information while changing format.
    - Increasing of resulting image file.
    - Do not use redundancy of digital image.
- Unformatted methods:
  - Main advantages:
    - Usage of digital image redundancy.
    - Less increasing of resultant image.
    - More stable for format transformations.
  - Main disadvantages:
    - Slow algorithms of information adding/extracting
    - Limited by the redundancy level (image type)





# Image models overview

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- All the unformatted methods use image redundancy based on the human vision system features.
- Information is added by changing some parts of the insignificant areas of digital image
- Insignificant parts of image can be found according to image model.



# Image models overview

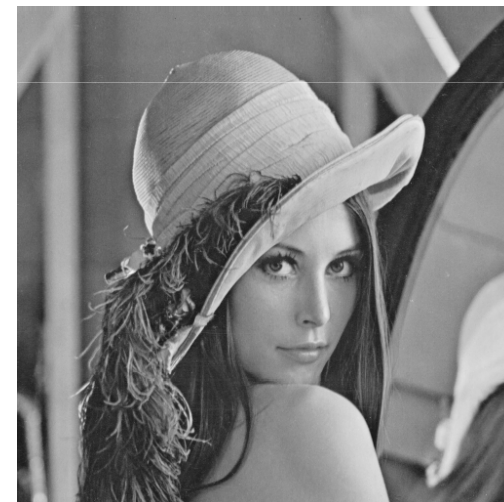
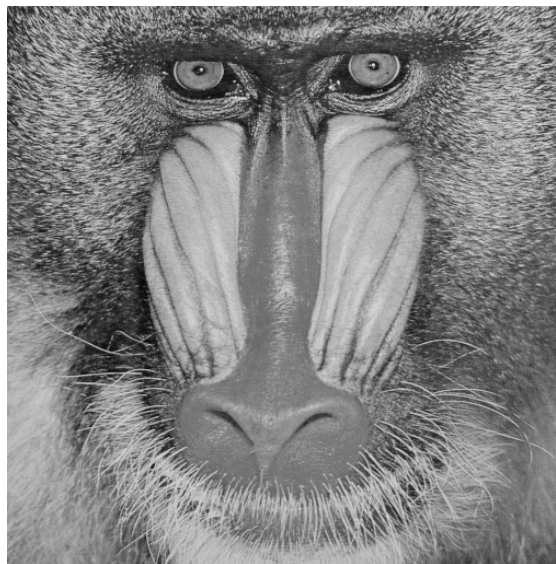
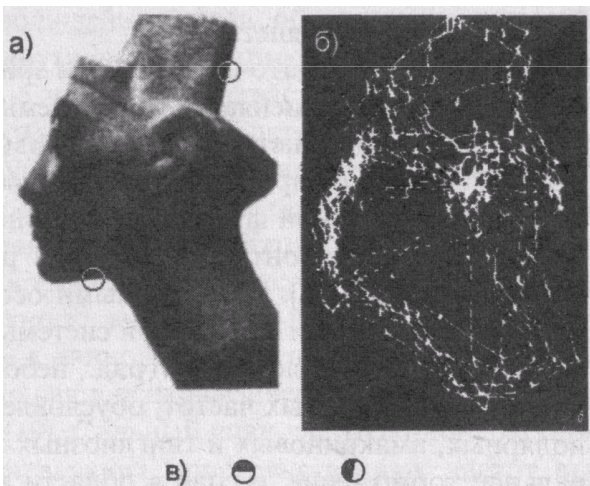
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Modern image models for non-graphic image type:

- Describe the value of the pixels:
  - RGB
  - YUV
- Describe the value of the transformation coefficients:
  - DCT
  - DWT
  - DFT
- Describe the object structure of the image:
  - Areas and boundaries

# Image models overview

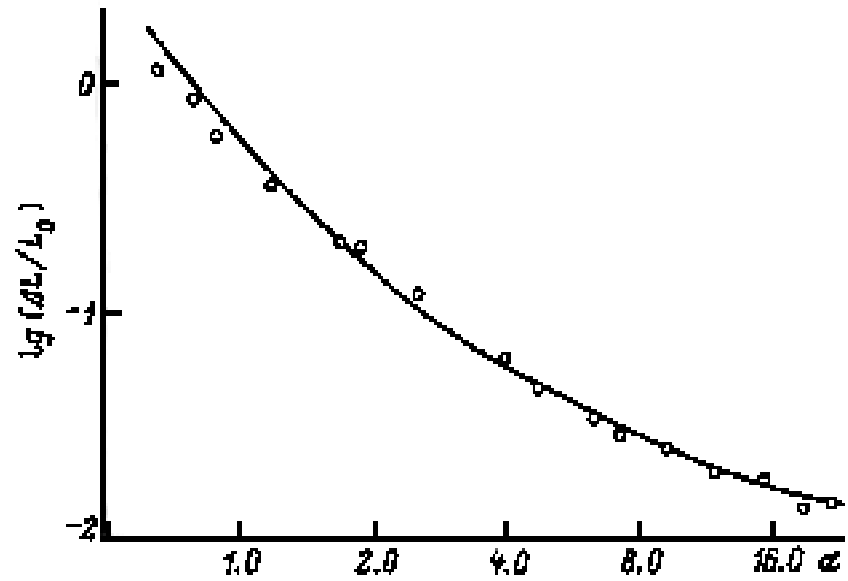
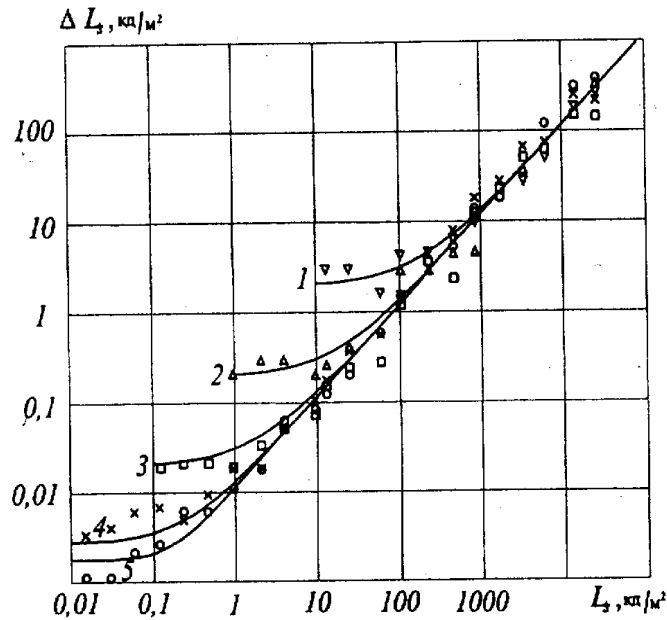
- semantic and non-semantic details



# Image models overview

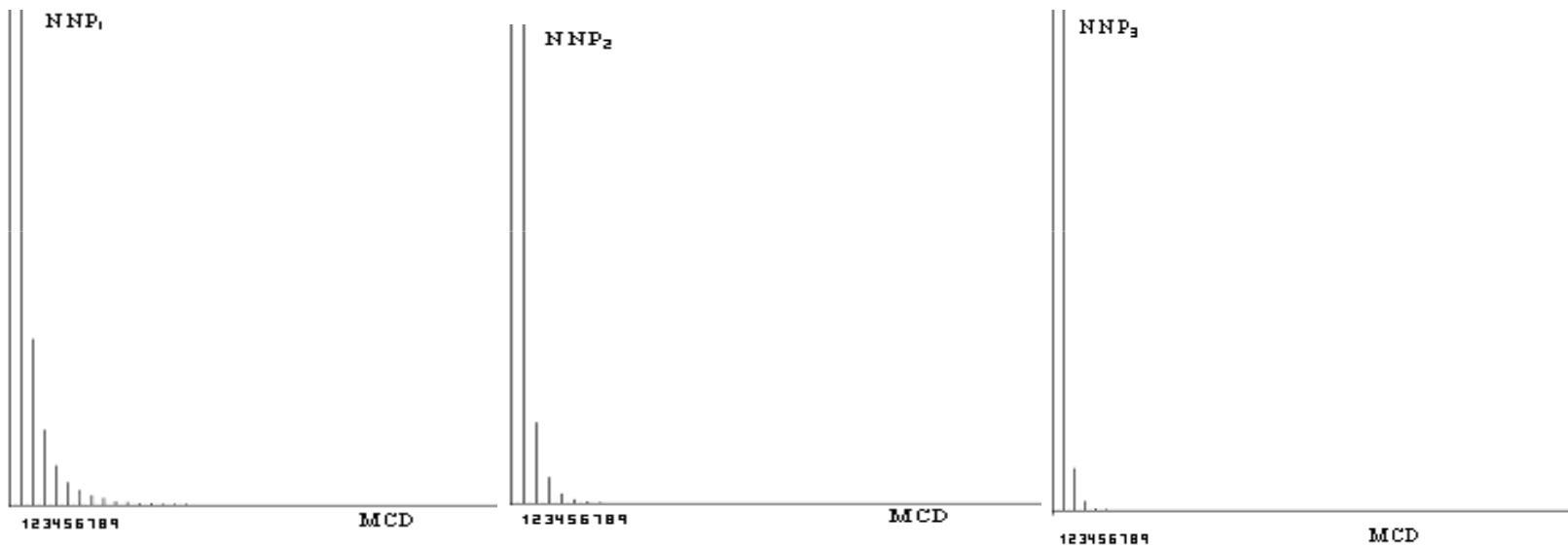
- Threshold contrast (TC)

$$\frac{\Delta L_s}{L_s} = \delta_1(a, \tau) \left(1 + \frac{c_1 L_a}{L_s}\right) \sqrt{1 + \frac{G}{(1 + c_1 L_a / L_s)^2 L_s}}$$



# Image models overview

## Image model type1



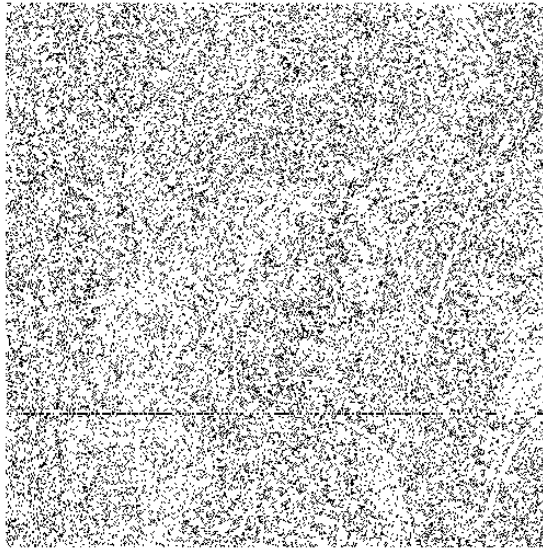
$$NNP_{DS, MCD} = \frac{NP_{DS, MCD}}{NP_{DS, 1}}$$

# Image models overview

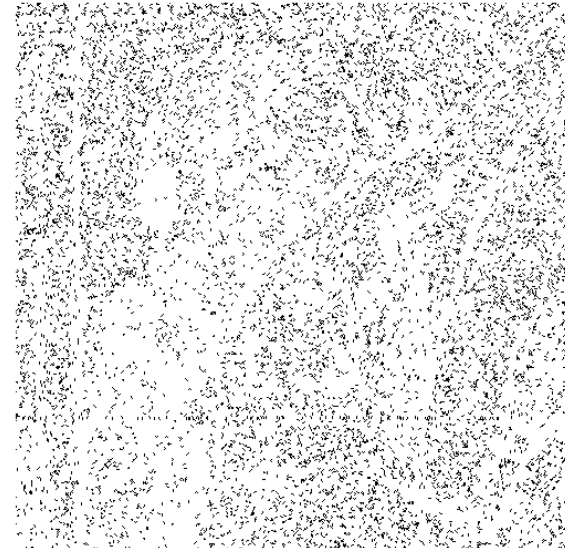
## Image model type1



DS=1 (1-pix)



DS=2 (2-pix)



DS=3 (3-pix)

- Areas of existing of DS-pix details (black -exist, white – not exist)

# Image models overview

## Image model type1



Conjoint area of existing 1-, 2-, 3-pixel details  
(black -exist, white – not exist)



Conjoint area of existing 1-7-pixel details with OT<sup>DS</sup>  
(black -exist, white – not exist)

# Image models overview

## Image model type1



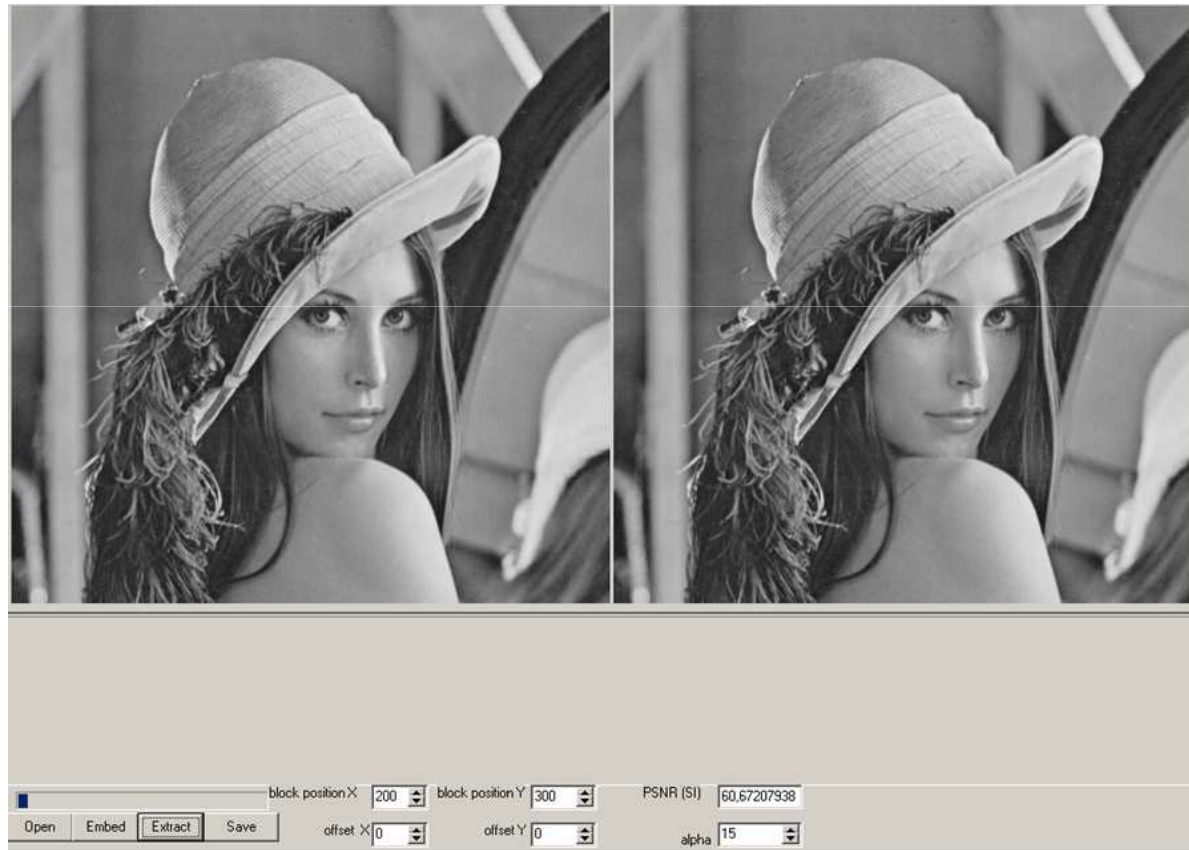
Initial test image (Lena.bmp)    Result test image (after preprocessing with OT<sup>DS</sup>)

DS, pix	0	1	2	3	4	5	6	7
OT <sup>DS</sup>		128	128	64	64	32	16	8



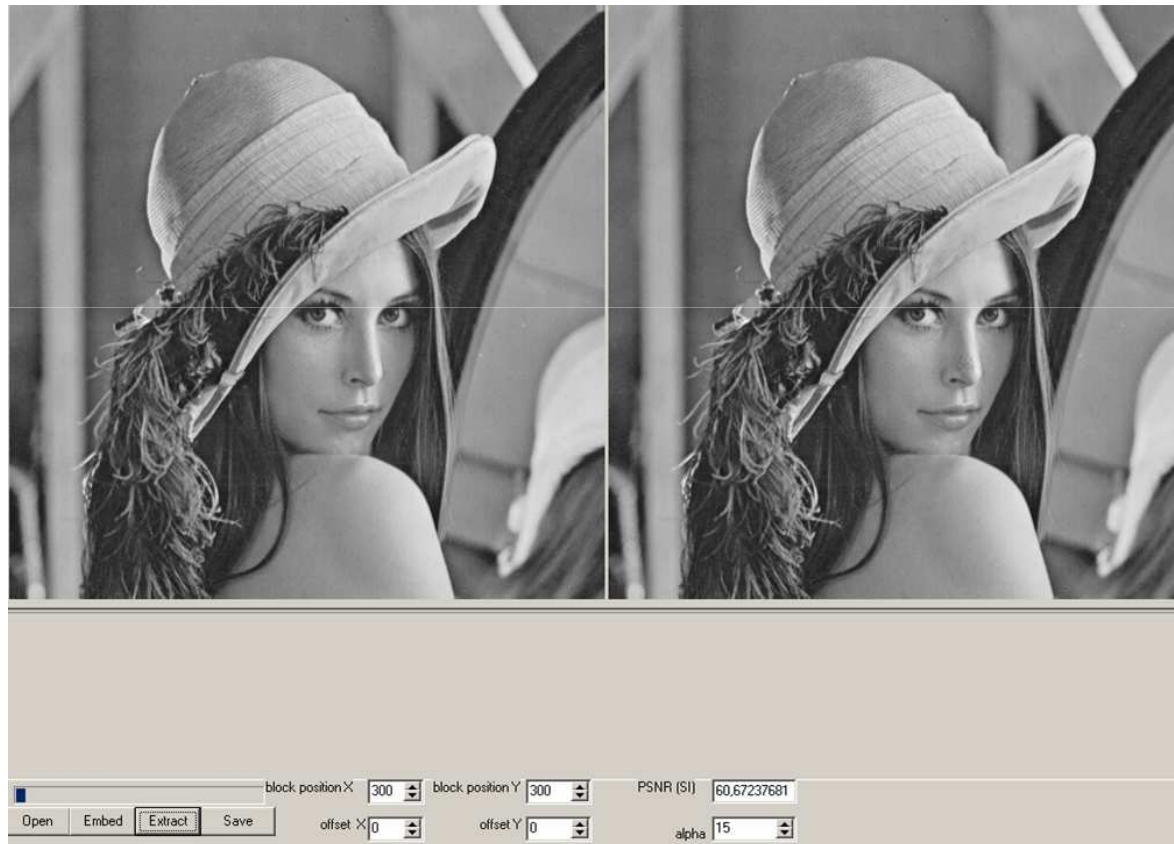
# Image models overview

## Image model type2



# Image models overview

## Image model type2





# Conclusions

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- Modern methods of adding information to digital images do not use the redundancy completely.
- Modern image models do not use (or use very roughly) levels of visual significance
- Modern image models do not represent all the levels of significance in a correct way.
- It's possible to find a new image model (type 3) with multilevel significance and create a new more efficient algorithm for increasing the information capacity of the digital images.



# Future research plans

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- Investigation of the low-significant areas of the digital images for adding information.
- Development of a new model of the digital images that represents it as a number of different visual significance level parts.
- Applying of the error-correcting codes with unequal error protecting property for more effective usage of image redundancy for information adding methods based on the new model.



Q & A

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**Thank you!**

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