Modern methods of increasing the information capacity of digital images

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Project description

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 psychophysititial redundancy of digital images.
The goal of the presentation

- 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
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

- 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

- 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

- **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

- 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

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)

\[
\frac{\Delta L_s}{L_s} = \delta_1(a, \tau)(1 + \frac{c_1 L_a}{L_s}) \sqrt{1 + \frac{G}{(1 + c_1 L_a / L_s)^2 L_s}}
\]
Image models overview

Image model type 1

\[ NNP_{DS,MCD} = \frac{NP_{DS,MCD}}{NP_{DS,1}} \]
Image models overview

Image model type 1

- **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 type 1

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

Conjoint area of existing 1-7-pixel details with $OT^{DS}$ (black - exist, white – not exist)
Image models overview

Initial test image (Lena.bmp)  Result test image (after preprocessing with $OT^{DS}$)

<table>
<thead>
<tr>
<th>DS, pix</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>$OT^{DS}$</td>
<td>128</td>
<td>128</td>
<td>64</td>
<td>64</td>
<td>32</td>
<td>16</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
Image models overview

Image model type2
Image models overview
Image model type2
Conclusions

- 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

- 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.
Thank you!

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