Image File Formats

CMPUT 206: Introduction to Digital Image Processing

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Source materials: http://www.imagingbook.com/

Image file formats

- Raster and vector image data
- Tagged image file format (TIFF)
- Graphics interchange format (GIF)
- Portable network graphics (PNG)
- Joint photographic experts group (JPEG)
- JPEG-2000
- Windows bitmap (BMP)
- Portable bitmap format (PBM)
- …

Raster and vector image data

- A raster format means "matrix format" of a digital image
- Vector format means representing geometric objects by continuous coordinates, e.g.,
  - A straight line is represented by the coordinates of its two end points
  - A circle will be represented by its center coordinates and its radius
- While displaying a vector image, the display devise/software has to convert it to a raster image
- Photoshop has both these capabilities to represent images
- Some image formats, such as, CGM (computer graphics metafile), SVG (scalable vector graphics), PS (postcript), EPS (enhanced postcript), PDF (portable document format), etc. have the capability to store both raster and vector image data

Indexed color image

Image

0	0	1	2	3
0	1	2	3	2
1	2	3	2	1
2	3	2	1	0
3	2	1	0	0

Colormap

0 =
1 =
2 =
3 =

Displayed image

An indexed image (source: wikipedia)

Windows bitmap, portable bitmap

- Windows bitmap (BMP) is a simple way to store images

- BMP supports indexed, true color, grayscale and binary images

- Portable bitmap (PGM) is another simple file format like BMP that stores files in a human readable text format, such as

```
P2
# oie.pgm
17 7
255
0 13 13 13 13 13 13 13  0  0  0  0  0  0  0  0  0
0 13  0  0  0  0  0 13  0  7  7  0  0 81 81 81 81
0 13  0  7  7  7  0 13  0  7  7  0  0 81  0  0  0
0 13  0  7  0  7  0 13  0  7  7  0  0 81 81 81  0
0 13  0  7  7  7  0 13  0  7  7  0  0 81  0  0  0
0 13  0  0  0  0  0 13  0  7  7  0  0 81 81 81 81
0 13 13 13 13 13 13 13  0  0  0  0  0  0  0  0  0
```

Tagged image file format (TIFF)

- A widely used and flexible file format designed to meet the professional needs

- Originally developed by Aldus, later extended by Microsoft, and now Adobe

- Supports grayscale, indexed and true color images

- TIFF specification provides a range of different compression methods (LZW, ZIP, CCITT, and JPEG) and color spaces

TIFF Architecture
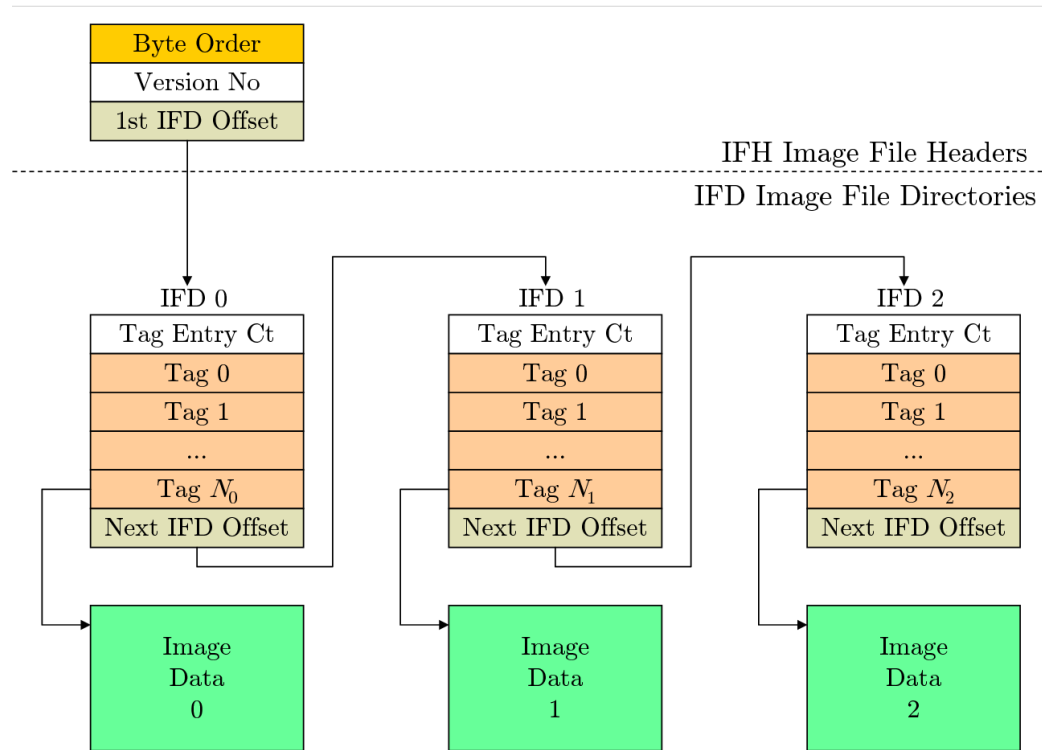
Structure of a TIFF file: a header and linked list of images

Graphics interchange format (GIF)

- Designed by CompuServe in 1986
- Was popular for web images
- Uses LZW compression, interlaced image coding
- Can encode simple animations by storing a number of images and showing them sequentially
- Indexed file format with a maximum depth of 8 bits
- Does not support true color images
- Can encode "flat" or iconic images very efficiently, because of indexed coloring system
- Uses lossless compressions

Portable network graphics (PNG)

- Originally developed as a replacement for GIF
- Supports three different types of images:
  - True color (with up to 3-by-16 bits/pixel
  - Grayscale (with up to 16 bits/pixel)
  - Indexed (with up to 256 colors)
- Includes an alpha channel for transparency with a maximum width of 16 bits
- Allows images of size up to 2^{30}-by-2^{30} pixels
- Supports PKZIP's lossless compression
- Superior to GIF in many ways

Joint photographic experts group

- JPEG is a compression method for color and grayscale images
- Goal was to achieve a data compression of 1:16
- Established in 1990 as ISO standard IS-10918
- In practice, it can achieve about 1:25 compression ratio for a 24-bit color image with acceptable viewable quality, i.e., equivalent to a bit rate of about 1 bit/pixel
- It is the most used image format today
- Supports CYMK color format
- Modular design and easy to implement
- Not designed for line drawings
- Block effects can be significant for some images
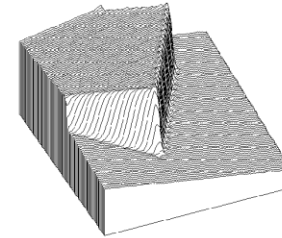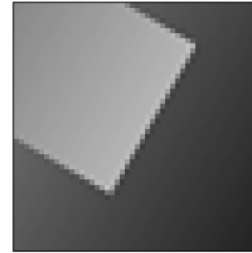
JPEG compression and decompression
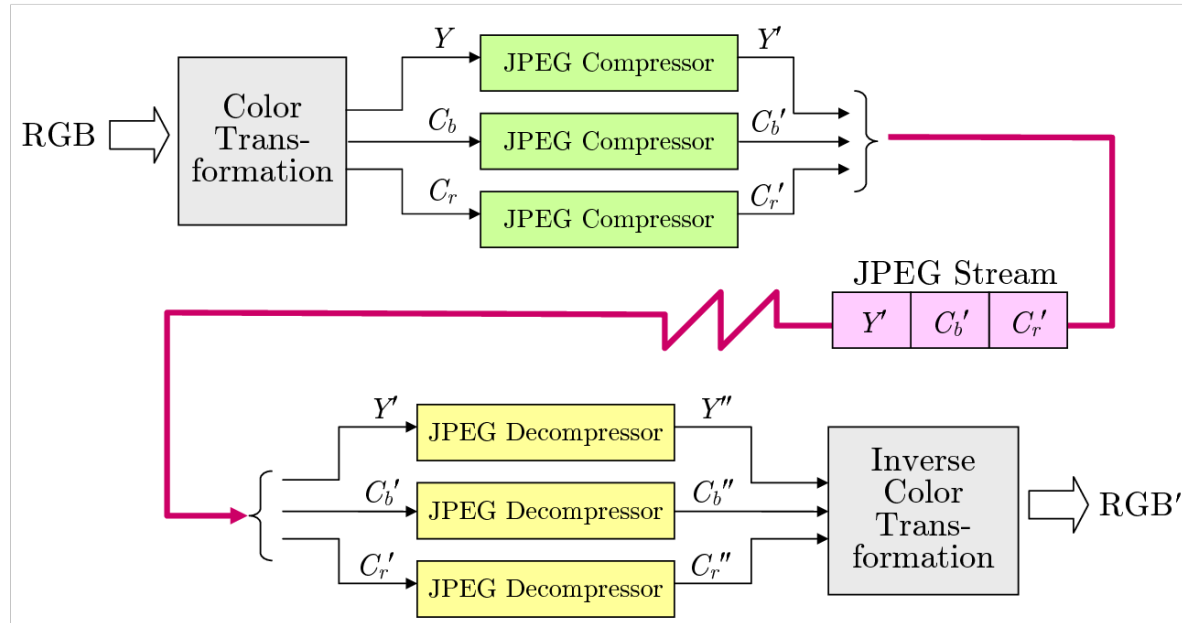
JPEG compression of an RGB image. Cb and Cr faces a higher rate of compression than the luminance Y. Color compression is based on human visual perception.
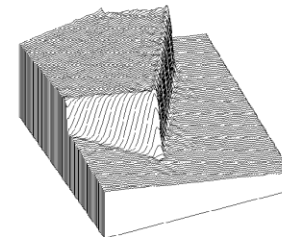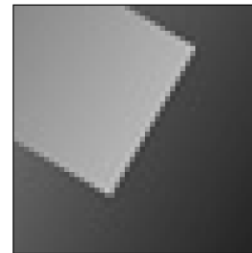
JPEG example in Photoshop

Artifacts arising from JPEG compression. Different compression quality of photoshop versus visual quality
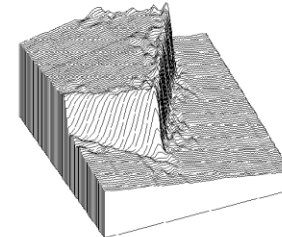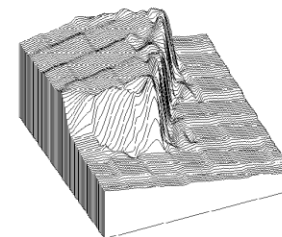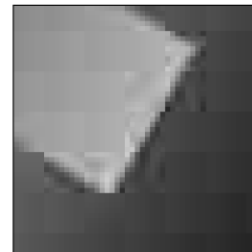

(a) Original (75.08 kB)

(b) $Q_{\text{JPG}} = 10$ (11.40 kB)

(c) $Q_{\text{JPG}} = 5$ (7.24 kB)

(d) $Q_{\text{JPG}} = 1$ (5.52 kB)

JPEG-2000

- Specified by ISO-ITU standard
- Uses larger image blocks than JPEG
- Uses wavelet transform, instead of discrete cosine transform of JPEG
- Achieves up to 0.25 bit/pixel compression ratio on RGB images
- Only a few image processing applications and web browsers support this format!