Compression and Graphics

COMP370
Intro to Computer Architecture
Pictures

• Vector – Pictures are drawn as a series of lines. The hardware draws a line from point A to point B.

• Raster – Pictures are represented as a matrix of picture elements or pixels.
Picture Size and Resolution

- Screen resolution is measured in horizontal and vertical pixels per inch.
- A good monitor can display about 90 pixels per inch.
- A good printer can print about 600 to 1200 pixels per inch.
- True size of a picture depends on the number of pixels and the device.
Pixel

- Each pixel has a color.
- Monochrome pictures have only two colors.
- The color is usually represented as three numbers that are the intensity of the three primary colors, Red, Green and Blue (RGB).
- The pixel represents both the color and the intensity or darkness of the pixel.
Bits / Pixel

- The number of bits it takes to represent a pixel depends on the number of possible colors.
- Black and white requires only 1 bits per pixel.
- Full color pictures require 24 bits per pixel.
- Simple graphics can use 4 or 8 bits per pixel.
Graphics Formats

• There are many formats for graphical data
  – BMP
  – JPEG
  – GIF
  – TIFF
  – PNG
  – etc.
Bit Mapped File

- BMP is a very simple format for graphics.
- Used frequently by Microsoft system.
- Each pixel is stored as a number. The number of bits per pixel is determined by the number of different colors.
# BMP format

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMP File Header</strong></td>
<td>Stores general information about the BMP file.</td>
</tr>
<tr>
<td><strong>Bitmap Information (DIB header)</strong></td>
<td>Stores detailed information about the bitmap image.</td>
</tr>
<tr>
<td><strong>Color Palette</strong></td>
<td>Stores the definition of the colors being used for indexed color bitmaps.</td>
</tr>
<tr>
<td><strong>Bitmap Data</strong></td>
<td>Stores the actual image, pixel by pixel.</td>
</tr>
</tbody>
</table>
BMP Efficiency

• Each pixel in a BMP file is represented by a number.
• There is no compression.
• It does not matter how “complex” the image, the file size is determined by the number of pixels or the size of the picture.
JPEG files

• The JPEG format was created by the Joint Photographic Experts Group
• JPEG is a commonly used method of compression for photographic images
• JPEG uses lossy compression. Some image quality is lost.
• You can control the level of compression and therefore the image quality.
• JPEG uses a Discrete cosine transform for compression.
JPEG Example

- $Q = 100$
- 81.3 KB
- 219,726 bytes if BMP
- 37% of BMP
JPEG Example

- Q = 50
- 14.7 KB
- 18% of Q100
- 6.7% of BMP
JPEG Example

- Q = 25
- 9.32 KB
- 11.5% of Q100
- 4.2% of BMP
JPEG Example

- \( Q = 10 \)
- 4.67 KB
- 5.7% of Q100
- 2.1% of BMP
JPEG Example

- Q = 1
- 1.48 KB
- 1.8% of Q100
- 0.67% of BMP
JPEG Artifacts

The JPE

Photo
Recommendations

- BMP files are not distorted in any way, but they are large.
- JPEG works well for photographs.
- GIF works well for diagrams or charts.
Text Compression Methods

• Reduce the number of bits per character
• Create a table of used characters. The data is represented as indexes into the table.
• Store repeating characters as a special marker and a run length.
• Lempel-Ziv-Welch (LZW) compression.
LZW Compression

- Lempel-Ziv-Welch (LZW) is a universal lossless data compression algorithm created by Abraham Lempel, Jacob Ziv, and Terry Welch in 1984.
- It creates a table of strings.
- Each time a new string is found it is entered in the table.
- Data is represented as indexes into the table.
LZW Algorithm

\[ w = \text{NIL}; \]
add all possible charcodes to the dictionary
for (every character c in the uncompressed data) do
  if ((\( w + c \)) exists in the dictionary) then
    \[ w = w + c; \]
  else
    add (\( w + c \)) to the dictionary;
    add the dictionary code for \( w \) to output;
    \[ w = c; \]
  endif
endif
done
add the dictionary code for \( w \) to output;
display output;