Computer Labs: The BMP file format
2º MIEIC

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Digital Image File Formats

XPM `xpm_load()`, by Pedro Silva, removes most of the limitations of `read_xpm()`

- ▶ It supports not only indexed but also direct color modes
- ▶ It can use XPMs generated by GIMP
- ▶ It does not support alpha compositing/channel:
  - ▶ Supports only transparent pixels, i.e. color "None"

bmp has been used by many LCOM projects in recent years

- ▶ It is relatively simple, and you can use some libraries available on the Web to load bmp files
  - ▶ However, some students have claimed that they had to make changes to some of these libraries
- ▶ It is supported by some well know graphics editors, e.g. GIMP

Reading a Pixmap from its XPM: `xpm_load()`

```
#define TRANSPARENCY_COLOR_1_5_5_5 0x8000
#define TRANSPARENCY_COLOR_8_8_8_8 0xFF000000
#define CHROMA_KEY_GREEN_888 0x00b140
#define CHROMA_KEY_GREEN_565 0x0588
enum xpm_image_type {
  XPM_INDEXED,
  XPM_1_5_5_5,
  XPM_5_6_5,
  XPM_8_8_8,
  XPM_8_8_8_8,
  INVALID_XPM
};
typedef struct {
  enum xpm_image_type type;
  uint16_t width;
  uint16_t height;
  size_t size;
  uint8_t *bytes;
} xpm_image_t;
uint8_t *(xpm_load)(xpm_map_t map, enum xpm_image_type type,
                    xpm_image_t *img);
```

The BMP File Structure

Bitmap File Header File metadata:

Bitmap Info Header/DIB Header Pixmap and pixel format metadata

▶ There are several versions, the most recent one is v5

Color Table/RGB Quad Array i.e. color palette

▶ Used mainly for indexed color representations

Pixel Array the pixmap

Other structures with extra information or for padding are optional.

Image with the BMP file fomat , via Wikipedia

Bitmap File Header

```
typedef struct tagBITMAPFILEHEADER {
  WORD  bfType;           // this is 2 bytes
  DWORD bfSize;           // this is 4 bytes
  WORD  bfReserved1;
  WORD  bfReserved2;
  DWORD bfOffBits;
};
```

Type Must be 'B"M', in ASCII
- ▶ But there other format versions

Size Size of file

OffBits Pixmap array offset (in file)

Bitmap Info Header

- ▶ Contains metadata about:

  Pixmap e.g. width and height

  Pixels e.g. bits per pixel or the RGB masks

- ▶ There are different versions
  - ▶ It has no field specifying the version
  - ▶ But, there is a field with the size of the header, and each version of the BitmapHeader has its own size

Bitmap Info Header v5 (the more recent)

```
typedef struct BITMAPV5HEADER { // DWORD, LONG: 4 bytes WORD: 2 bytes
  DWORD        bV5Size; // this header size
  LONG         bV5Width;
  LONG         bV5Height; // If negative, first row is top
  WORD         bV5Planes;
  WORD         bV5BitCount; // Bits per pixel
  DWORD        bV5Compression;
  DWORD        bV5SizeImage;
  LONG         bV5XPelsPerMeter;
  LONG         bV5YPelsPerMeter;
  DWORD        bV5ClrUsed;
  DWORD        bV5ClrImportant;
  DWORD        bV5RedMask;
  DWORD        bV5GreenMask;
  DWORD        bV5BlueMask;
  DWORD        bV5AlphaMask;
  DWORD        bV5CSType;
  CIEXYZTRIPLE bV5Endpoints; // 36 bytes
  DWORD        bV5GammaRed;
  DWORD        bV5GammaGreen;
  DWORD        bV5GammaBlue;
  DWORD        bV5Intent;
  DWORD        bV5ProfileData;
  DWORD        bV5ProfileSize;
  DWORD        bV5Reserved;
}
```

Bitmap Color Table

- ▶ Is used for indexed color formats
  - ▶ Determined by the `BitCount`, i.e. bits per pixel, and the `Compression` fields
- ▶ But can also be used for direct color formats
  - ▶ In this case, the number of entries in the table is given by the `ClrUsed` fields of the BitmapHeader
- ▶ I do not recall of its use in LCOM projects

Bitmap Pixel Array

Pixel[0,h-1]	Pixel[1,h-1]	Pixel[2,h-1]	...	Pixel[w-1,h-1]	Padding
Pixel[0,h-2]	Pixel[1,h-2]	Pixel[2,h-2]	...	Pixel[w-1,h-2]	Padding
			⋮		
Pixel[0,9]	Pixel[1,9]	Pixel[2,9]	...	Pixel[w-1,9]	Padding
Pixel[0,8]	Pixel[1,8]	Pixel[2,8]	...	Pixel[w-1,8]	Padding
Pixel[0,7]	Pixel[1,7]	Pixel[2,7]	...	Pixel[w-1,7]	Padding
Pixel[0,6]	Pixel[1,6]	Pixel[2,6]	...	Pixel[w-1,6]	Padding
Pixel[0,5]	Pixel[1,5]	Pixel[2,5]	...	Pixel[w-1,5]	Padding
Pixel[0,4]	Pixel[1,4]	Pixel[2,4]	...	Pixel[w-1,4]	Padding
Pixel[0,3]	Pixel[1,3]	Pixel[2,3]	...	Pixel[w-1,3]	Padding
Pixel[0,2]	Pixel[1,2]	Pixel[2,2]	...	Pixel[w-1,2]	Padding
Pixel[0,1]	Pixel[1,1]	Pixel[2,1]	...	Pixel[w-1,1]	Padding
Pixel[0,0]	Pixel[1,0]	Pixel[2,0]	...	Pixel[w-1,0]	Padding

src: Wikipedia

- ▶ Pixmap represented as an array of rows
  - ▶ Size of each row must be a multiple of 4 bytes
  - ▶ Unless `height` is negative, the first row is the bottom row

Bitmap Pixel Array: Pixel Format

▶ Is determined by fields of the bitmap header:

Planes must be 1

BitCount , i.e. bits per pixel

Compression specifies not only if there is compression, but also the pixel format. E.g. `BI_BITFIELDS` indicates that the format "is not compressed and that the color masks for the red, green, and blue components of each pixel are specified in the bV5RedMask, bV5GreenMask, and bV5BlueMask members."

RedMask, GreenMask, BlueMask, AlphaMask

Further Reading

- João Cardoso, Notas sobre *Sprites*
- Wikipedia, BMP file format
- Microsof, Bitmap Storage
- Microsoft, BITMAPV5HEADER structure
- FileFormat Info, Microsoft Windows Bitmap File Format Summary