Computer Labs: Lab 5 & Sprites

2º MIEIC

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Lab5: Video Card in Graphics Mode - 2nd Lab Class

- Write a set of functions (**tentative**):

```
int video_test_xpm(char *xpm, unsigned short xi,
                   unsigned short yi, ...)
int video_test_move(char *xpm, unsigned short xi,
                       unsigned short yi, ...)
int video_test_controller()
```

- Update `video_test_init()`, so that it uses VBE function 0x01, Return VBE Mode Information.
  - Rather than an hard-coded value

Lab 5: `video_test_xpm()`

```
video_test_xpm(char *xpm[], unsigned short xi,
               unsigned short yi )
```

What Display the XPM provided in the `xpm` array at the screen coordinates `(xi,yi)`

- Use VBE mode `0x105`

Pixmaps and XPM

pixmap is a short term for “pixel map”, the representation of a graphic image as an array of pixel color values

- I.e. it is a map of screen coordinates to color values
- **bitmap** is a pixmap that uses a single bit to denote the color of each pixel

XPM X Pixmap is an image format that allows to represent a pixmap in a textual form, by representing each color value by a different character

- An XPM for a given pixmap can be stored either in a text file, or in a data structure of a C program
- This is a simplified version of XPM: the XPM format allows to use more than one character to encode the color

Example: Using C Arrays to Store XPMs

```
static char *pic1[] = {
"32 13 4", /* number of columns and rows, in pixels, and color
". 0", /* '.' denotes color value 0 */
"x 2", /* 'x' denotes color value 2 */
"o 14", /* .. and so on */
"+ 4",
"................................", /* the map  */
"..............xxx...............",
"............xxxxxxx.............",
".........xxxxxx+xxxxxx..........",
"......xxxxxxx+++++xxxxxxx.......",
"....xxxxxxx+++++++++xxxxxxx.....",
"....xxxxxxx+++++++++xxxxxxx.....",
"......xxxxxxx+++++xxxxxxx.......",
".........xxxxxx+xxxxxx..........",
"..........ooxxxxxxxoo...........",
".......ooo...........ooo........",
".....ooo...............ooo......",
"...ooo...................ooo...."
};
```

Question How many elements does an XPM array have?

Lab 5: `video_test_xpm()`

```
video_test_xpm(char *xpm[], unsigned short xi,
               unsigned short yi)
```

What Display the XPM provided in the `xpm` array at the screen coordinates `(xi,yi)`

- Use VBE mode `0x105`

Issue How to convert the XPM to a pixmap?

Answer Use the `read_xpm()` function

Generating a Pixmap from its XPM: `read_xpm()`

```
int width, height;
char *map;

// get the pix map from the XPM
map = read_xpm(pic1, &width, &height);

// copy it to graphics memory
```

`char *read_xpm(char* pic1, int *w, int *h)`

reads an XPM description of a pixmap `pic1`, and returns the pixmap as a two-dimensional char array of `*h` lines, each of which with `*w` pixels. It assumes that the XPM uses:

- One char per color – this is enough if we have few colors
- One byte per color – this is OK for mode `0x105`

Lab 5: `video_test_move()`

```
int video_test_move( char *xpm[],,
                     unsigned short xi, unsigned short yi,
                     unsigned short xf, unsigned short yf
                     short speed, unsigned short frame_rate)
```

What? Move a sprite on the screen (only along the x or y axes)

- `xpm` XPM for the sprite
- `(xi,yi)` initial coordinates (of ULC)
- `(xf,yf)` final coordinates (of ULC)
- `speed` speed
  - If non-negative number of pixels between consecutive frames
  - If negative number of frames required for a 1 pixel movement
- `frame_rate` number of frames per second

The “Class” Sprite: `sprite.h`

Sprite “Two-dimensional image that is integrated into a larger scene” (Wikipedia)

- Allows the integration of independent pixmaps into a scene
- Allows image animation without altering the background – thus a sprite can be considered an overlay image

```
typedef struct {
    int x, y; // current position
    int width, height;  // dimensions
    int xspeed, yspeed; // current speed
    char *map;          // the pixmap
} Sprite;
```

The pixmap uses **black** (or some unused color) for the background, which is assumed to be transparent

The “Class” Sprite: `sprite.c`

```
/** Creates a new sprite with pixmap "pic", with specified
 *  position (within the screen limits) and speed;
 * Does not draw the sprite on the screen
 * Returns NULL on invalid pixmap.
 */
Sprite *create_sprite(char *pic[], int x, int y,
                      int xspeed, int yspeed) {

    //allocate space for the "object"
    Sprite *sp = (Sprite *) malloc ( sizeof(Sprite));
    if( sp == NULL )
        return NULL;

    // read the sprite pixmap
    sp->map = read_xpm(pic, &(sp->width), &(sp->height));
    if( sp->map == NULL ) {
        free(sp);
        return NULL;
    }
    ...
    return sp;
}
```

The “Class” Sprite: sprite.c

```
void destroy_sprite(Sprite *sp) {
    if( sp == NULL )
        return;
    if( sp ->map )
        free(sp->map);
    free(sp);
    sp = NULL;     // XXX: pointer is passed by value
                   //            should do this @ the caller
}

int animate_sprite(Sprite *sp) {
    ...
}

/* Some useful non-visible functions */
static int draw_sprite(Sprite *sp, char *base) {
    ...
}
static int check_collision(Sprite *sp, char *base) {
    ...
}
```

Lab 5: `test_move()`

```
int video_test_move( char *xpm[],,
                     unsigned short xi, unsigned short yi,
                     unsigned short xf, unsigned short yf
                     short speed, unsigned short frame_rate)
```

What? Move a sprite on the screen (only along the x or y axes)

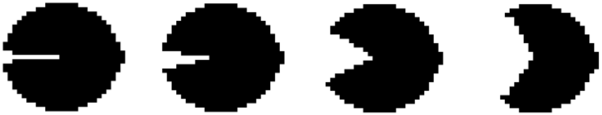
`xpm`	XPM for the sprite
`(xi,yi)`	initial coordinates (of ULC)
`(xf,yf)`	final coordinates (of ULC)
`speed`	speed
If non-negative	number of pixels between consecutive frames
If negative	number of frames required for a 1 pixel movement
`frame_rate`	number of frames per second

How? Should use the `sprite` "class"

- But you can change it slightly (I did).
- Need not implement all functions.

Sprite Animation

- Animation of a sprite can be achieved by presenting a sequence of pixmaps
  - Each pixmap (but the first) in this sequence differs slightly from the previous pixmap



- To create an animated sprite we need to specify several pixmaps
  - This can be done in different ways
- We'll use a C function with a variable number of arguments:

```
AnimSprite *create_animSprite(char *pic1[], ...);
```

`printf()` is the most common C function of this type

(Functions with a Variable Number of Arguments)

- Must have at least one argument
- Usually need to know how many arguments
  - Can find out using macros provided (see ex. `AnimSprite`, below)
- Uses a list of variable arguments of type `va_list`
- Relies on a set of macros defined in `<stdarg.h>`, which implement a kind of iterator for accessing that list:

  `va_start` to initialize the list
  `va_arg` to access the next argument (list element)
  `va_end` to finalize the access

```
#include <stdarg.h> // va_* macros are defined here
int foo(int required, ...) {
    va_list var_args;
    va_start(var_args, required);
    int i = va_arg(var_args, int);
    float i = va_arg(var_args, float);
    char *s = va_arg(var_args, char *);
    va_end(var_args);
```

The “Class” Animated Sprite: `AnimSprite.h`

```
#include <stdarg.h> // va_* macros are defined here
#include "sprite.h"
typedef struct {
    Sprite *sp;      // standard sprite
    int aspeed;      // no. frames per pixmap
    int cur_aspeed; // no. frames left to next change
    int num_fig;     // number of pixmaps
    int cur_fig;     // current pixmap
    char **map;      // array of pointers to pixmaps
} AnimSprite;

AnimSprite(char *pic1[], ...);
int animate_animSprite(AnimSprite *sp,);
void destroy_animSprite(AnimSprite *sp);
```

Animation speed is measured as number of “frames” per pixmap

The “Class” Animated Sprite: `AnimSprite.c` (1/2)

```
AnimSprite *create_animSprite(char *pic1[], ...) {
    AnimSprite *asp = malloc(sizeof(AnimSprite));
    // create a standard sprite with first pixmap
    asp->sp = create_sprite(pic1,0,0,0,0);
    // find out the number of variable arguments
    va_list var_args; // variable arguments
    int args;
    // find out the length of the va_args list
    va_start(va_args, pic1); // initialize va_args list
    // iterate over that list
    for(args = 0; va_arg(var_args, char**) != NULL; args++);
    va_end(var_args); // done with va_args list, for now
    // allocate array of pointers to pixmaps
    asp->map = malloc((args+1) * sizeof(char *));
    // initialize the first pixmap
    asp->map[0] = asp->sp->map;
    // continues in next transparency
```

The “Class” Animated Sprite: `AnimSprite.c` (2/2)

```
    // initialize the remainder with the variable arguments
    // iterate over the var_args list again
    va_start(var_args, pic1);
    for( i = 1; i <args+1; i++ ) {
        char **tmp = va_arg(var_args, char **);
        asp->map[i] = read_xpm(tmp, &w, &h);
        if( asp->map[i] == NULL
            || w != asp->sp->width || h != asp->sp->height) {
            // failure: realease allocated memory
            for(j = 1; j<i;j ++)
                free(asp->map[i]);
            free(asp->map);
            destroy_sprite(asp->sp);
            free(asp);
            va_end(var_args);
            return NULL;
        }
    }
    va_end(var_args);
    ...
}
```

Thanks to:

I.e. shamelessly translated material by:

- João Cardoso (jcard@fe.up.pt)

Further Reading

- João Cardoso, Notas sobre *Sprites*