ECS251 Project

The OS design for ECS 251

Team Members

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OS Outline

The designed API is aim for the game developer to develop the gaming environment easier. Our testing game is the Snake Game. The Snake game combined the standard input and output system such as mouse, keyboard, and monitor. We design various API functions for these kernel operations, and we also have some API functions like malloc and random number generator to allocate OS resource and generate random numbers.

Page Outline

API List

▼ **All new added APIs are highlighted with red background**

Memory Management

- **malloc() - Allocates the requested memory and returns a pointer to it**

```
// Signature
#include "memory.c"
void* malloc(size_t size)

// Parameters
int size - the required memory size

// Return Value
A void pointer to the allocated space, or NULL if there's insufficient memory
available.
```

Random Number Generator

- **genRandom() - generate a random number**

```
// Signature
#include "api.h"
int genRandom(int high);

// Parameters
int high - define the range from 0 to high (not inclusive)

// Return Value
return random_value
```

I/O Controller API

- **getStatus(): Listen to key inputs from keyboard**

```
// Signature
#include "api.h"
uint32_t getStatus(void);

// Parameters
void


// Return Value
return status
```

Mode Switch API

- **setTextMode() - change to text mode**

```
// Signature
#include "api.h"
void setTextMode(void);

// Parameters
void


// Return Value
no return value
```

- **setGraphicsMode() - change to graphics mode**

```
// Signature
#include "api.h"
void setGraphicsMode(void);

// Parameters
void


// Return Value
no return value
```

Text API

- **printLine() - Print a line of texts on screen in text mode**

```
// Signature
#include "api.h"
void printLine(char* string);

// Parameters
char* string - defines a string

// Return Value
no return value
```

Graphics API

- **setColor() - Set a specific color by assigning ARGB values to sprite palette**

```
// Signature
#include "api.h"
void setColor(int palette_id, int entry_id, uint32_t rgba);

// Parameters
int palette_id - defines which palette to assign color
int entry_id - defines which entry to assign color.
uint32_t rgba - defines the rgba value of color

// Return Value
no return value
```

- **setBackgroundColor() - Set a specific color by assigning ARGB values to background palette**

```
// Signature
#include "api.h"
void setBackgroundColor(int palette_id, int entry_id, uint32_t rgba);

// Parameters
int palette_id - defines which palette to assign color
int entry_id - defines which entry to assign color.
uint32_t rgba - defines the rgba value of color

// Return Value
no return value
```

- **calcSmallSpriteControl() - Calculate the 32 bit value of the small sprite controller**

```
// Signature
#include "api.h"
uint32_t calcSmallSpriteControl(uint32_t x, uint32_t y, uint32_t w, uint32_t h,
uint32_t p);

// Parameters
uint32_t x - defines the x coordinate of the left_upper corner of the rectangle.
uint32_t y - defines the y coordinate of the left_upper corner of the rectangle.
uint32_t w - defines the width of the rectangle.
uint32_t h - defines the height of the rectangle.
uint32_t p - defines the palette id that stores the color you want
```

```
// Return Value
return controller_value
```

- **calcLargeSpriteControl() - Calculate the 32 bit value of the large sprite controller**

```
// Signature
#include "api.h"
uint32_t calcLargeSpriteControl(uint32_t x, uint32_t y, uint32_t w, uint32_t h,
uint32_t p);

// Parameters
uint32_t x - defines the x coordinate of the left_upper corner of the rectangle.
uint32_t y - defines the y coordinate of the left_upper corner of the rectangle.
uint32_t w - defines the width of the rectangle.
uint32_t h - defines the height of the rectangle.
uint32_t p - defines the palette id that stores the color you want

// Return Value
return controller_value
```

- **calcBackgroundControl() - Calculate the 32 bit value of the background controller**

```
// Signature
#include "api.h"
uint32_t calcLargeSpriteControl(uint32_t x, uint32_t y, uint32_t z, uint32_t p);

// Parameters
uint32_t x - defines x position of the image
uint32_t y - defines y position of the image
uint32_t z - defines z position of the image
uint32_t p - defines the palette id that stores the color you want

// Return Value
return controller_value
```

- **setSmallSpriteControl() - Draw a rectangle with the small sprite controller**

```
// Signature
#include "api.h"
void setSmallSpriteControl(int sprite_id, uint32_t addr);

// Parameters
```

```
int sprite_id - defines id of sprite
uint32_t addr - defines the 32 bits to set the sprite

// Return Value
no return value
```

- **setLargeSpriteControl() - Draw a rectangle with the large sprite controller**

```
// Signature
#include "api.h"
void setLargeSpriteControl(int sprite_id, uint32_t addr);

// Parameters
int sprite_id - defines id of sprite
uint32_t addr - defines the 32 bits to set the sprite

// Return Value
no return value
```

- **setBackgroundSpriteControl() - Draw a rectangle with the background sprite controller**

```
// Signature
#include "api.h"
void setBackgroundSpriteControl(int sprite_id, uint32_t addr);

// Parameters
int sprite_id - defines id of sprite
uint32_t addr - defines the 32 bits to set the sprite

// Return Value
no return value
```

- **shiftSmallSpriteControl() - Shift controller to new coordinates**

```
// Signature
#include "api.h"
void shiftSmallSpriteControl(int sprite_id, uint32_t x, uint32_t y);

// Parameters
int sprite_id - defines id of sprite
uint32_t x - defines the x coordinate expected to shift to
uint32_t y - defines the y coordinate expected to shift to
```

```
// Return Value
no return value
```

- **shiftLargeSpriteControl() - Shift controller to new coordinates**

```
// Signature
#include "api.h"
void shiftLargeSpriteControl(int sprite_id, uint32_t x, uint32_t y);

// Parameters
int sprite_id - defines id of sprite
uint32_t x - defines the x coordinate expected to shift to
uint32_t y - defines the y coordinate expected to shift to

// Return Value
no return value
```

- **getSmallSpriteControl() - Get the 32 bit value of the controller**

```
// Signature
#include "api.h"
uint32_t getSmallSpriteControl(int sprite_id);

// Parameters
int sprite_id - defines id of sprite

// Return Value
return the stored 32-bit value
```

- **getLargeSpriteControl() - Get the 32 bit value of the controller**

```
// Signature
#include "api.h"
uint32_t getLargeSpriteControl(int sprite_id);

// Parameters
int sprite_id - defines id of sprite

// Return Value
return the stored 32-bit value
```

- **getBackgroundSpriteControl() - Get the 32 bit value of the controller**

```
// Signature
#include "api.h"
uint32_t getBackgroundSpriteControl(int sprite_id);

// Parameters
int sprite_id - defines id of sprite

// Return Value
return the stored 32-bit value
```

Multithreading

- **initContext() - Create a new thread**

```
// Signature
#include "api.h"
TContext initContext(uint32_t *stacktop, TEntry entry, void *param);

// Parameters
uint32_t *stacktop
TEntry entry
void *param

// Return Value
return TContext
```

- **switchContext() - Switch threads**

```
// Signature
#include "api.h"
void SwitchContext(TContext *old, TContext new);

// Parameters
TContext *old - defines the thread that are original thread
TContext new - defines the thread that are next thread to be run on

// Return Value
no return value
```

Timer API

- **getTicks() - Get the current time**

```
// Signature
#include "api.h"
uint32_t getTicks(void);

// Parameters
void

// Return Value
return global
```

Video Interrupt

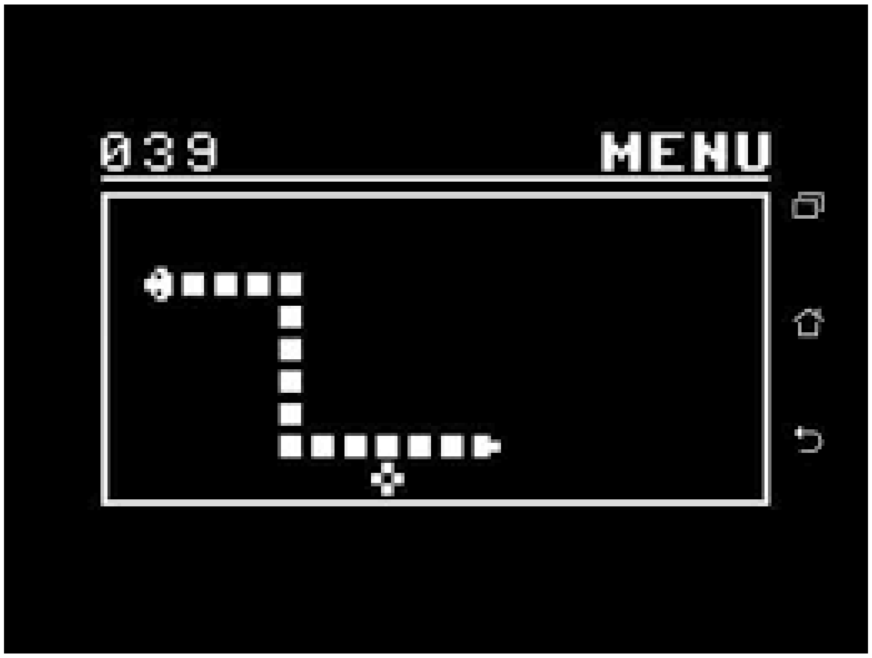
- **getVideoInterruptCount() - Get the number of occurrence of video interrupt**

```
// Signature
#include "api.h"
int getVideoInterruptCount(void);

// Parameters
void

// Return Value
return video_interrupt_count
```

Game Selection - Snake Game



Sample Demo; Source: https://play.google.com/store/apps/details?id=com.sbtstudio.snakegame&hl=en_CA&gl=US

Strengths of our OS: How our APIs help game developers implement the Snake Game

General Purpose

- `Random number generator` makes it easier for developers to assign random numbers to whatever needed in their game.
- `I/O controller API` provides manipulations of system input and output.
- `Graphics API` can be used for the standard output, such as setting the desired RGB values.
- `Timer API` provides access to timers for developers to keep track of the elapsed game time or the countdown of the remaining time.

Snake Game

- `Random number generator` can generate a random coordinate for the next target pellet.
- `I/O controller API` controls the snake's direction on the monitor from keyboard input and receive the commands or picture pixel from the game and pass through to the monitor.
- `Graphics API` assigns the colors if the game is multicolored. The default of the game is black and white.

Reference

- stack pointer - https://www.techtarget.com/whatis/definition/stack-pointer
- mmap - https://linuxhint.com/using_mmap_function_linux/
- multithreading - https://www.ibm.com/docs/en/xl-fortran-aix/15.1.3?topic=openmp-omp-get-num-threads
- random number generator - https://man7.org/linux/man-pages/man2/getrandom.2.html
- thread functions - https://www.geeksforgeeks.org/thread-functions-in-c-c/