lab3 实验报告

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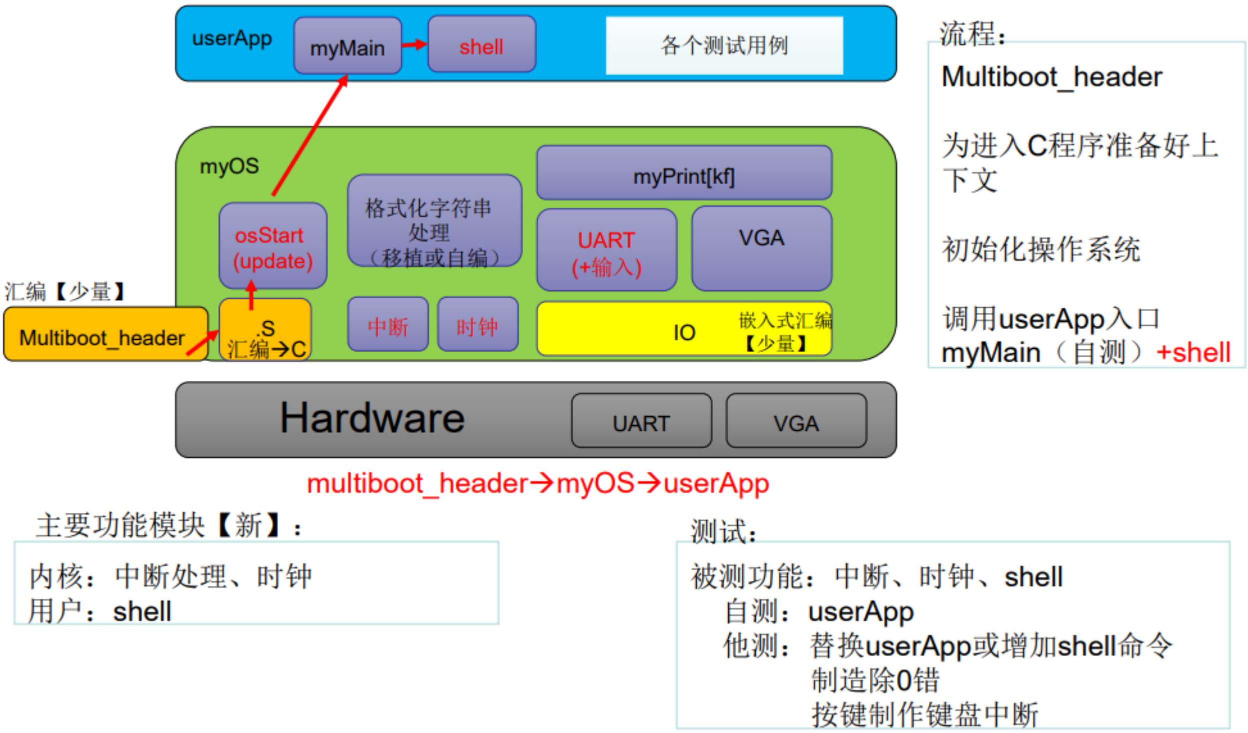
一、实验内容

- 【必须】简单的 shell 程序，提供 cmd 和 help 命令，允许注册新的命令
- 【必须】中断机制和中断控制器 i8259A 初始化
- 【必须】时钟 i8253 和周期性时钟中断
- 【必须】VGA 输出的调整：
    - 左下角：时钟中断之外的其他中断，一律输出“unknown interrupt”
    - 右下角：从某个时间开始，大约每秒更新一次格式为：HH:MM:SS
- 【必须】采用自定义测试用例和用户（助教）测试用例相结合的方式进行验收
- 【必须】提供脚本完成编译和执行

二、实验原理

- 软件的架构(框图)



流程：

Multiboot_header

为进入C程序准备好上下文

初始化操作系统

调用userApp入口

myMain（自测）+shell

主要功能模块【新】：

内核：中断处理、时钟

用户：shell

测试：

被测功能：中断、时钟、shell

自测：userApp

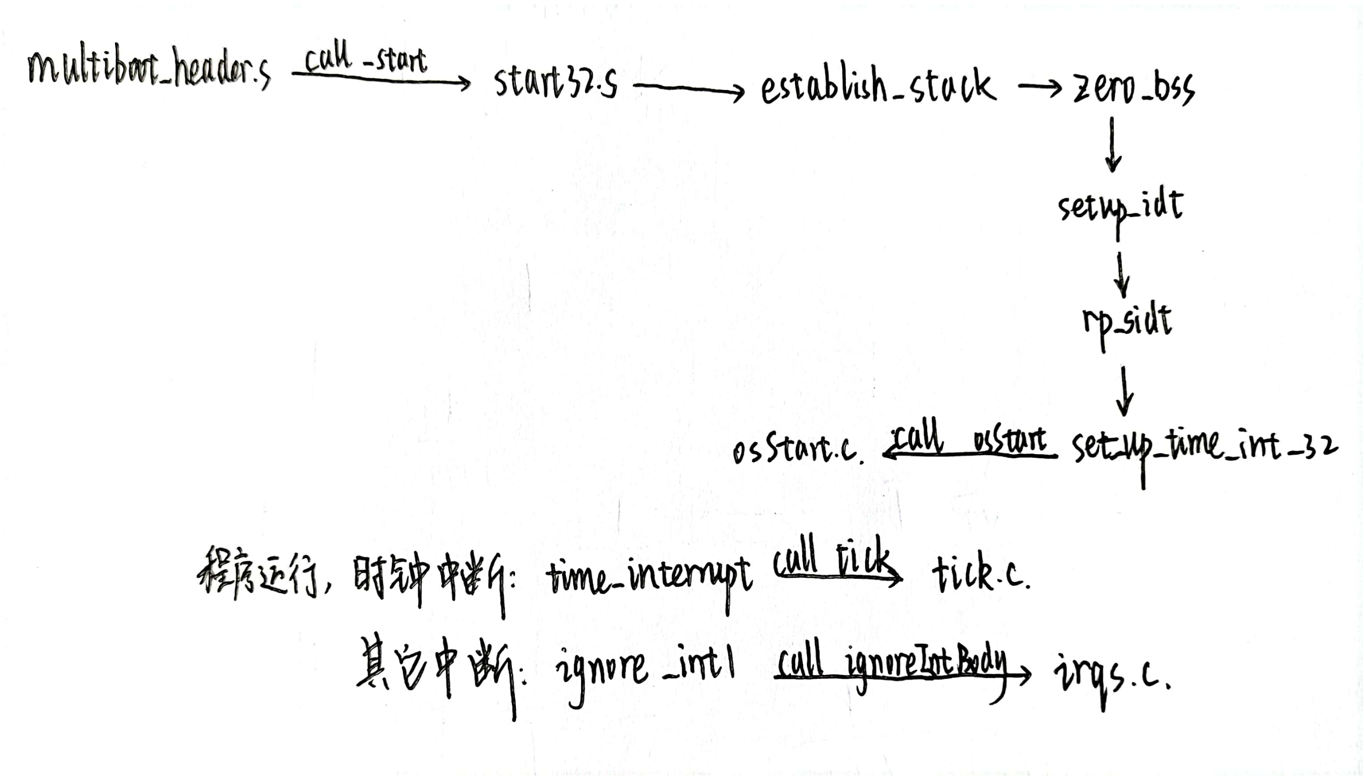
他测：替换userApp或增加shell命令

制造除0错

按键制作键盘中断

三、实验过程

1. 代码的主流程



2. 主要功能模块及其实现

- myOS/start32.S 中的 time_interrupt 和 ignore_int1 的填写

```
time_interrupt:
    cld
    pushf
    pusha
    call tick
    popa
    popf
    iret

    .p2align 4
ignore_int1:
    cld
    pusha
    call ignoreIntBody
    popa
    iret
```

- myOS/dev/i8253.c 和 myOS/dev/i8259A.c 的填写

```
void init8253(void)
{
    //你需要填写它
    unsigned short fre = 1193180 / 100;
    outb(0x43, 0x34);
    outb(0x40, (unsigned char)(fre & 0xff));
    outb(0x40, (unsigned char)((fre >> 8) & 0xff));
    outb(0x21, (unsigned char)(inb(0x21) & 0xfe));
}
void init8259A(void)
{
    //你需要填写它
    //屏蔽所有中断源
    outb(0x21, 0XFF);
    outb(0xA1, 0xFF);
    //主片初始化
    outb(0x20, 0x11);
    outb(0x21, 0x20);
    outb(0x21, 0x04);
    outb(0x21, 0x3);
    //从片初始化
    outb(0xA0, 0x11);
    outb(0xA1, 0x28);
    outb(0xA1, 0x02);
    outb(0xA1, 0x01);
}
```

- myOS/i386/irq.s 的填写

```
enable_interrupt:
    sti
    ret
    .globl disable_interrupt
disable_interrupt:
    cli
    ret
```

- myOS/kernel/tick.c 和 myOS/kernel/wallClock.c 的填写

```
void tick(void)
{
    system_ticks++;
    int temp = system_ticks / 100;
    HH = temp / (60 * 60);
    MM = temp / 60 - HH * 60;
    SS = temp % 60;
    oneTickUpdateWallClock(HH, MM, SS);
    return;
}
void setWallClock(int HH, int MM, int SS)
{
    char time_str[9];
    time_str[0] = '0' + HH / 10;
    time_str[1] = '0' + HH % 10;
    time_str[2] = ':';
    time_str[3] = '0' + MM / 10;
    time_str[4] = '0' + MM % 10;
    time_str[5] = ':';
    time_str[6] = '0' + SS / 10;
    time_str[7] = '0' + SS % 10;
    time_str[8] = '\0';

    unsigned short int *p;
    unsigned short int pos = 80 * 25 - 8;
    unsigned short int data;
    unsigned short int base = 0x2 << 8;
    p = (unsigned short int *)(VGA_BASE + pos * 2);
    for (int i = 0; i < 9; i++)
    {
        data = base + time_str[i];
        *p = data;
        p += 1;
    }
    return;
}
void getWallClock(int *HH, int *MM, int *SS)
{
    unsigned short int *p;
    unsigned short int pos = 80 * 25 - 8;
    p = (unsigned short int *)(VGA_BASE + pos * 2);

    char c = (*p) & 0xff;
    *HH = (c - '0') * 10;
    p += 2;
    c = (*p) & 0xff;
    *HH += (c - '0');

    p += 2 * 2;
    c = (*p) & 0xff;
    *MM = (c - '0') * 10;
    p += 2;
    c = (*p) & 0xff;
    *MM += (c - '0');

    p += 2 * 2;
    c = (*p) & 0xff;
    *SS = (c - '0') * 10;
    p += 2;
    c = (*p) & 0xff;
    *SS += (c - '0');
    return;
}
```

- userApp/startShell.c 的填写

  新增加了 clear 清屏和 echo 输出函数，简单修改了终端窗口的颜色，适应了\b 的功能，添加了 split 函数

```
int func_cmd(int argc, char (*argv)[8])
{
    if (argc != 1)
        myPrintk(0x7, "unrecognized command line option\n\n");
    else
    {
        myPrintk(0x7, "1.  ");
        myPrintk(0x7, cmd.name);
        myPrintk(0x7, "\n");
        myPrintk(0x7, "2.  ");
        myPrintk(0x7, help.name);
        myPrintk(0x7, "\n");
        myPrintk(0x7, "3.  ");
        myPrintk(0x7, clear.name);
        myPrintk(0x7, "\n");
        myPrintk(0x7, "4.  ");
        myPrintk(0x7, echo.name);
        myPrintk(0x7, "\n");
    }
}
int judge_command(char *str)
{
    if (str[0] == 'c' && str[1] == 'm' && str[2] == 'd' && str[3] == '\0')
        return 1;
    if (str[0] == 'h' && str[1] == 'e' && str[2] == 'l' && str[3] == 'p' && str[4] == '\0')
        return 2;
    if (str[0] == 'c' && str[1] == 'l' && str[2] == 'e' && str[3] == 'a' && str[4] == 'r' && str[5] == '\0')
        return 3;
    if (str[0] == 'e' && str[1] == 'c' && str[2] == 'h' && str[3] == 'o' && str[4] == '\0')
        return 4;
    return 0;
}
int func_help(int argc, char (*argv)[8])
{
    if (argc == 1)
        myPrintk(0x7, help.help_content);
    else
    {
        if (judge_command(argv[1]) == 1)
            myPrintk(0x7, cmd.help_content);
        else if (judge_command(argv[1]) == 2)
            myPrintk(0x7, help.help_content);
        else if (judge_command(argv[1]) == 3)
            myPrintk(0x7, clear.help_content);
        else if (judge_command(argv[1]) == 4)
            myPrintk(0x7, echo.help_content);
        else
            myPrintk(0x7, "No Such Command please use cmd to see more information");
    }
    myPrintk(0x7, "\n");
}
int func_clear(int argc, char (*argv)[8])
{
    if (argc != 1)
        myPrintk(0x7, "unrecognized command line option\n");
    else
        clear_screen();
}
int func_echo(int argc, char (*argv)[8])
{
    myPrintk(0x7, argv[1]);
    myPrintk(0x7, "\n");
}
int split(char *str, char (*argv)[8], int len)
{
    int iter = 0;
    int num = 0;
    int i = 0;
    while (iter < len)
    {
        if (str[iter] != ' ')
        {
            argv[num][i] = str[iter];
            i++;
            iter++;
        }
        else
        {
            argv[num][i] = '\0';
            num++;
            i = 0;
            iter++;
        }
    }
    argv[num][i] = '\0';
    num++;
    return num;
}
void startShell(void)
{
    //我们通过串口来实现数据的输入
    char BUF[256];   //输入缓存区
    int BUF_len = 0; //输入缓存区的长度

    int argc;
    char argv[8][8];

    do
    {
        BUF_len = 0;
        myPrintk_only_vga(0xa, "voyage@qemu");
        myPrintk_only_vga(0xf, "$ ");
        uart_put_chars("\e[32;1mvoyage@qemu\e[0m\e[1m$ \e[0m");

        char str_for_out[2];
        str_for_out[1] = '\0';

        while ((BUF[BUF_len] = uart_get_char()) != '\r')
        {
            if (BUF[BUF_len] == 127 && BUF_len == 0)
            {
                continue;
            }
            else if (BUF[BUF_len] == 127)
            {
                myPrintk(0x7, "\b \b");
                BUF_len--;
                continue;
            }
            uart_put_char(BUF[BUF_len]); //将串口输入的数存入BUF数组中
            str_for_out[0] = BUF[BUF_len];
            myPrintk_only_vga(0x7, str_for_out);
            BUF_len++; // BUF数组的长度加
        }
        BUF[BUF_len] = '\0';

        myPrintk(0x7, "\n");
        // OK,助教已经帮助你们实现了“从串口中读取数据存储到BUF数组中”的任务，接下
来你们要做
        //的就是对BUF数组中存储的数据进行处理(也即，从BUF数组中提取相应的argc和
argv参
        //数)，再根据argc和argv，寻找相应的myCommand ***实例，进行
***.func(argc,argv)函数
        //调用。

        //比如BUF中的内容为 “help cmd”
        //那么此时的argc为2 argv[0]为help argv[1]为cmd
        //接下来就是 help.func(argc, argv)进行函数调用即可
        argc = split(BUF, argv, BUF_len);
        if (judge_command(argv[0]) == 1)
            func_cmd(argc, argv);
        else if (judge_command(argv[0]) == 2)
            func_help(argc, argv);
        else if (judge_command(argv[0]) == 3)
            func_clear(argc, argv);
        else if (judge_command(argv[0]) == 4)
            func_echo(argc, argv);
        else if (BUF[0] == '\0')
        {
        }
        else
        {
            myPrintk(0x7, "Command");
            myPrintk(0xf, " %s ", BUF);
            myPrintk(0x7, "not found!\n");
        }
```

```
    } while (1);
}
```

3. 源代码组织说明

- 项目结构

```
├── compile_flags.txt
├── Makefile
├── multibootheader
│   └── multibootHeader.S
├── myOS
│   ├── dev
│   │   ├── i8253.c
│   │   ├── i8259A.c
│   │   ├── Makefile
│   │   ├── uart.c
│   │   └── vga.c
│   ├── i386
│   │   ├── io.c
│   │   ├── irq.S
│   │   ├── irqs.c
│   │   └── Makefile
│   ├── include
│   │   ├── i8253.h
│   │   ├── i8259A.h
│   │   ├── io.h
│   │   ├── irqs.h
│   │   ├── myPrintk.h
│   │   ├── tick.h
│   │   ├── uart.h
│   │   ├── vga.h
│   │   ├── vsprintf.h
│   │   └── wallClock.h
│   ├── kernel
│   │   ├── Makefile
│   │   ├── tick.c
│   │   └── wallClock.c
│   ├── Makefile
│   ├── myOS.ld
│   ├── osStart.c
│   ├── printk
│   │   ├── Makefile
│   │   ├── myPrintk.c
│   │   └── vsprintf.c
│   └── start32.S
├── source2run.sh
└── userApp
    ├── main.c
    ├── Makefile
    └── startShell.c
```

- Makefile 组织

```
.
├── MULTI_BOOT_HEADER
│   └── output/multibootheader/multibootHeader.o
└── OS_OBJS
    ├── MYOS_OBJS
    │   ├── output/myOS/osStart.o
    │   ├── output/myOS/start32.o
    │   ├── DEV_OBJS
    │   │   ├── output/myOS/dev/uart.o
    │   │   ├── output/myOS/dev/vga.o
    │   │   ├── output/myOS/dev/i8259A.o
    │   │   └── output/myOS/dev/i8253.o
    │   ├── I386_OBJS
    │   │   ├── output/myOS/i386/io.o
    │   │   ├── output/myOS/i386/irqs.o
    │   │   └── output/myOS/i386/irq.o
    │   ├── PRINTK_OBJS
    │   │   ├── output/myOS/printk/myPrintk.o
    │   │   └── output/myOS/printk/vsprintf.o
    │   └── KERNEL_OBJS
    │   │   ├── output/myOS/kernel/tick.o
    │   │   └── output/myOS/kernel/wallClock.o
    └── USER_APP_OBJS
        ├── output/userApp/main.o
        └── output/userApp/startShell.o
```

4. 代码布局说明

Section	Offset (Base = 1M)
.multiboot_header	0
.text	8
.data	16
.bss	16
_end	16

四、编译运行过程

直接运行脚本文件

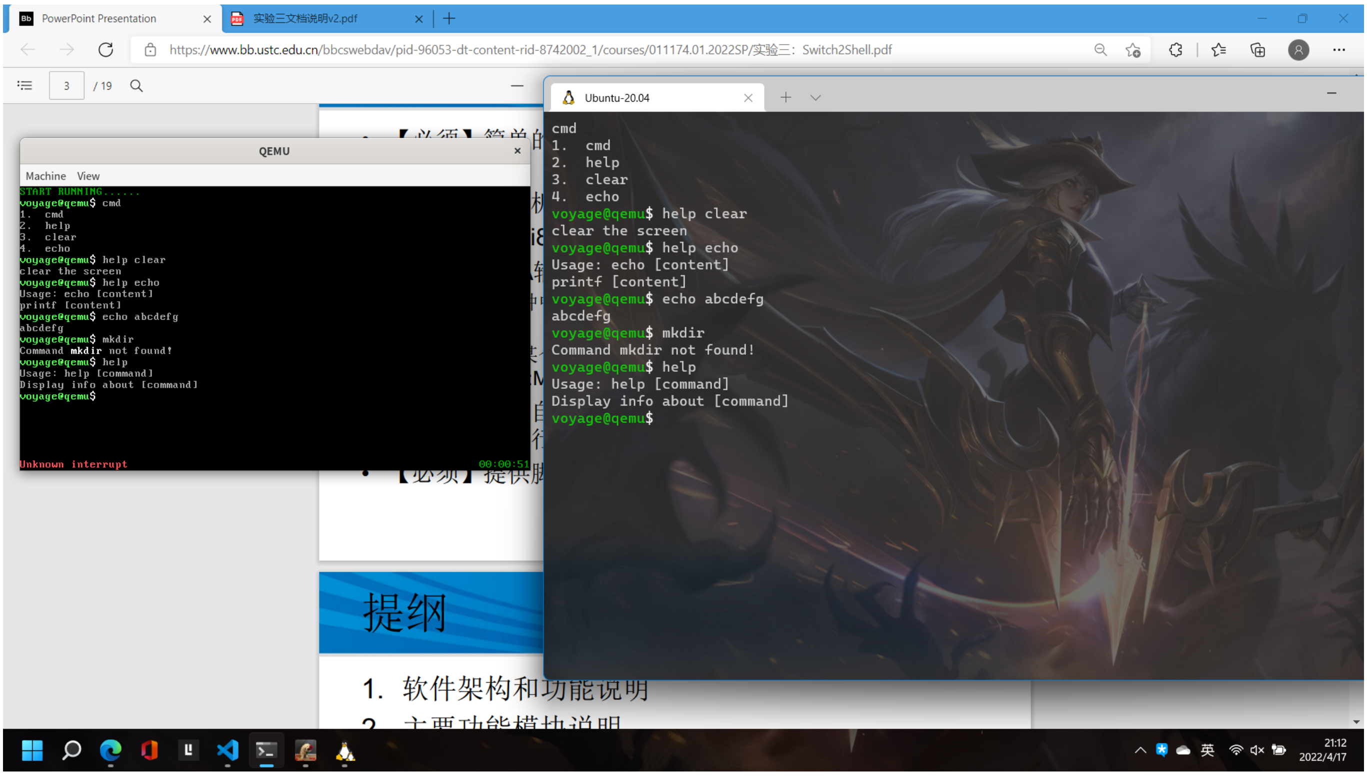
```
./source2img.sh
```

根据提示重定向串口输入

脚本的执行:

- 编译各个文件，生成相应的 .o 目标文件
- 根据链接描述文件，将各 .o 目标文件进行链接，生成`myOS.elf`文件
- 使用 qemu，调用上一步生成的文件，进行模拟

五、运行结果



PowerPoint Presentation
实验三文档说明v2.pdf
https://www.bb.ustc.edu.cn/bbcswebdav/pid-96053-dt-content-rid-8742002_1/courses/011174.01.2022SP/实验三：Switch2Shell.pdf
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QEMU
Machine View
Ubuntu-20.04
提纲
1. 软件架构和功能说明
21:12
2022/4/17

```
START RUNNING......
voyage@qemu$ cmd
1.  cmd
2.  help
3.  clear
4.  echo
voyage@qemu$ help clear
clear the screen
voyage@qemu$ help echo
Usage: echo [content]
printf [content]
voyage@qemu$ echo abcdefg
abcdefg
voyage@qemu$ mkdir
Command mkdir not found!
voyage@qemu$ help
Usage: help [command]
Display info about [command]
voyage@qemu$



Unknown interrupt                                   00:00:51
```

```
cmd
1.  cmd
2.  help
3.  clear
4.  echo
voyage@qemu$ help clear
clear the screen
voyage@qemu$ help echo
Usage: echo [content]
printf [content]
voyage@qemu$ echo abcdefg
abcdefg
voyage@qemu$ mkdir
Command mkdir not found!
voyage@qemu$ help
Usage: help [command]
Display info about [command]
voyage@qemu$
```

六、实验收获

- 熟悉了汇编到 C 的过程
- 熟悉了操作系统相关的接口
- 学习了 shell 脚本
- 熟悉了终端机制
- 学习了 HOOK 相关机制
    - 实现了机制与策略相分离，提供了用户重新编写 mysetWallClock，并调用 setWallClockHook(mysetWallClock)的权利