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题　　目： RongOS — 简单操作系统的实现

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摘　要： 操作系统管理着计算机的硬件和软件资源，它是向上层应用软件提供服务（接口）的核心系统软件，这些服务包括进程管理，内存管理，文件系统，网络通信，安全机制等。操作系统的设计与实现则是软件工业的基础。为此，在国务院提出的《中国制造 2025》中专门强调了操作系统的开发[1]。但长期以来，操作系统核心开发技术都掌握在外国人手中，技术受制，对于我们的软件工业来说很不利。本项目从零开始设计开发个简单的操作系统，包括 boot loader，中断，内存管理，图形接口，多任务，以及在这个系统上的几个小应用等。尽管这个系统很简单，但它为自主开发操作系统做了尝试。

关键词： 操作系统，进程，内存，中断，boot loader

RongOS — A simple OS implementation

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Abstract: Operating system manages the resources of hardware and software, it lies in the core of the system software and provides services(interfaces) to upper applications. These services include process management, memory management, file system, network communication, security mechanism and more. Operating system development is the foundation and core of software industry. Therefore, *Made in China 2025* emphasizes the development of operating system that put forward by The State Council of China. For a long time, however, the OS kernel development technology is mastered by foreigner, due to technical limitations it is detrimental to our software industry. So this project will design and develop a simple operating system, including boot loader, interrupt, memory management, graphic interface, multitasking, and some little applications based on this system. In spite of the simplicity of this system, it's a small trying for autonomous development operating system.

Key words: operating system, boot loader, process, interrupt, memory management

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1 Introduction

1.1 Background

Contemporary software systems are beset by problems that create challenges and opportunities for broad new OS research. There are five areas could improve user experience including dependability, security, system configuration, system extension, and multiprocessor programming.

The products of forty years of OS research are sitting in everyone's desktop computer, cell phone, car, etc., and it is not a pretty picture. Modern software systems are broadly speaking complex, insecure, unpredictable, prone to failure, hard to use, and difficult to maintain. Part of the difficult is that good software is hard to write, but in the past decade, this problem and more specific shortcomings in systems have been greatly exacerbated by increased networking and embedded systems, which placed new demands that existing architectures struggled to meet. These problems will not have simple solutions, but the changes must be pervasive, starting at the bottom of the software stack, in the operating system.

The world needs broad operating system research. Dependability, security, system configuration, system extension, and multi-processor programming illustrate areas were contemporary operating systems have failed to meet the software challenges of the modern computing environment.

1.2 Preliminary Works

1.2.1 Development Environment

OS platform: Debian 9, Linux kernel 4.12.0-1-amd64

Editor: GNU Emacs 25.2.2

Run time VM: QEMU emulator 2.8.1

Assembler: Nask.

Compiler: compiler?

Debugger: debugger?

1.2.2 Tools

Some tools used to develop RongOS, see tools.[1].

need more words.

1.2.3 Platform Setup

Debian System: there is a small tutorial.[2]

Qemu

What's Qemu?

QEMU, for my x86_64 architecture:

```
$ sudo apt-get install qemu-system-x86_64
```

Wine

What's Wine?

Note that the tools is exe formate, so on Debian system, you need to install wine:

```
$ sudo apt-get update
$ sudo apt-get install wine
```

Debian i386 support

Maybe you also need to add i386 architecture cause of AMD64 on your machine to use these tools: need rephrase

```
$ sudo dpkg --add-architecture i386
$ sudo apt-get update
```

[1] https://github.com/Puqiyuan/RongOS/tree/master/Tools
[2] http://cs2.swfc.edu.cn/~wx672/lecture_notes/linux/install.html

2 Leading Knowledge

2.1 Instruction Set

An instruction set architecture (ISA) is an abstract model of a computer. It is also referred to as architecture or computer architecture. An ISA defines everything a machine language programmer needs to know in order to program a computer.

An ISA may be classified in a number of different ways. A common classification is by architectural complexity. A complex instruction set computer (CISC) has many specialized instructions, some of which may only be rarely used in practical programs. A reduced instruction set computer (RISC) simplifies the processor by efficiently implementing only the instructions that are frequently used in programs, while the less common operations are implemented as subroutines, having their resulting additional processor execution time offset by infrequent use.

On traditional architectures, an instruction includes an opcode that specifies the operation to perform, such as add contents of memory to register—and zero or more operand specifiers, which may specify registers, memory locations, or literal data. The simple OS is based on x86 architecture, the following instructions are common for RongOS:

db: the abbreviation of define byte, write a byte, also 8 bits to file.

resb: the abbreviation of reserve byte, reserved bytes and filling 0x00 in these reserved space.

dw: the abbreviation of define word, write two bytes, also 16 bits to file.

dd: the abbreviation of define double-word, write four bytes, also 32 bits to file.

org: load the program to specified address.

jmp: jump to another instruction.

mov: assign the right value to left variable.

2.2 x86 Registers

In computer architecture, a processor register is a quickly accessible location available to a computer's central processing unit (CPU). Registers usually consist of a small amount of fast storage, although some registers have specific hardware functions, and may be read-only or write-only. Almost all computers, whether load/store architecture or not, load data from a larger memory into registers where it is used for arithmetic operations and is manipulated or tested by machine instructions. Manipulated data is then often stored back to main memory, either by the same instruction or by a subsequent one. Modern processors use either static or dynamic RAM as main memory, with the latter usually accessed via one or more cache levels.

Processor registers are normally at the top of the memory hierarchy, and provide the fastest way to access data. The term normally refers only to the group of registers that are directly encoded as part of an instruction, as defined by the instruction set. Registers are normally measured by the number of bits they can hold, for example, an "8-bit register" or a "32-bit register". For x86 architecture, these registers existing:

ax: accumulator
bx: base
cx: counter
dx: data
bl: base low
al: accumulator low
cl: counter low
dl: data low
bh: base high
ah: accumulator high
ch: counter high
dh: data high
sp: stack pointer
bp: base pointer
si: source index
di: destination index
es: extra segment
cs: code segment
ss: stack segment
ds: data segment
fs: no name

In these registers, bx, bp, si and di can be used to specify the address of memory. But ax, cx, dx and sp can not. When mov instruction using, the number of bit of operation number should be same. 16 bits registers: ax, cx, dx, bx, sp, bp, si, di, es, cs, ss, ds and fs. 8 bits registers: al, cl, dl, bl, ah, ch, dh and bh. Actually, all these 8 bits registers are part of corresponding 16 bits registers, low 8 bits or high 8 bits.

2.3 Interrupt Call

BIOS interrupt calls perform hardware control or I/O functions requested by a program, return system information to the program, or do both. A key element of the purpose of BIOS calls is abstraction-the BIOS calls perform generally defined functions, and the specific details of how those functions are executed on the particular hardware of the system are encapsulated in the BIOS and hidden from the program. The following interrupt calls are common for RongOS:

Interrupt Number	Register Parameter	Return Value	Function
0x10	ah=0x0e(write character in tty mode) al=character code bh=0, bl=colorcolor	null	video services
0x13	ah=0x02(read sectors) ah=0x03(write sectors) ah=0x04(verify sectors) ah=0x0c(seek to specified track) al=number of sectors processing ch=cylinder & 0xff dh=header number dl=driver number	FLACS.CF=0 no error, ah = 0 FLAGS.CF=1 error, ah=error number	disk services

3 Design

3.1 Top Level Design

Missing figure

System overview diagram

need some description

3.2 Detailed Design

3.2.1 Boot Loader

This is the workflow of the boot loader.

Question: is this section about how bootloader works, or about how to load it into the mem?

need a new figure

图 3-1 Workflow of the boot loader

Missing figure

MBR structure

the 446 bytes code in MBR is for …

The instructions of the boot loader saved in C0-H0-S1 of floppy, the first cylinder, head

0, the first sector, total 512 byte. These instructions end with `0x55 0xaa`, so BIOS will load C0-H0-S1 to memory, then the instructions in C0-H0-S1 will load C0-H0-S2 — C9-H1-S18, total $10 * 2 * 18 * 512 = 184320byte = 180KB$(including boot sector, C0-H0-S1) to main memory.

3.2.2 32-bit Mode and Import C Codes

4 Implementation

4.1 Boot Loader

4.1.1 Choose Disk

need rephrase

There are many ways to boot an operating system, from hard disk, USB, floppy disk, etc. Among which, floppy disk is the simplest one to deal with, though it's out of date. ~~I choose floppy disk, although it is out of date. For my purpose is that develop a simple operating system, pay my attention on how to development.~~ The structure of floppy disk is simple and for my simple operating system it's enough.

4.1.2 The Structure of a Floppy Disk

Fig. 4-1 shows the inside of a floppy disk:

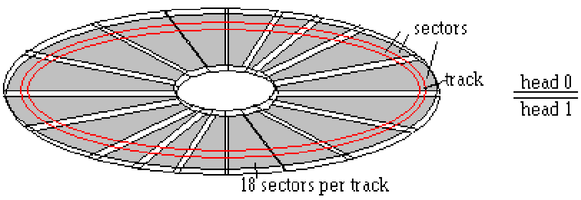

图 4-1 Floppy Disk Structure

A floppy disk~~, also called a floppy, diskette, or just disk~~, is a type of disk storage composed of a disk of thin and flexible magnetic storage medium, sealed in a rectangular plastic enclosure lined with fabric that removes dust particles. Floppy disks are read and written by a floppy disk drive (FDD)`\cite{}`.

cite wikipedia

For 3.5 inch HD floppy, There are 80 cylinders from the outermost to the core on each side, numbering 0, 1, ..., 79. The head can assign be 0 or 1, representing two sides of floppy. When specify head number and cylinder number, forming a ring, named track in jargon. The track is large so we divide it to 18 small parts, named sector. A sector can store 512 byte. So the capacity of a floppy is:

$$18 \times 80 \times 2 \times 512 = 1474560Byte = 1440KB$$

4.1.3 Flowchart of Boot Loader

Fig. 4-2 shows how the boot loader works.

need a better chart

图 4-2 Flowchart of Boot Loader

The boot loader is implemented in Intel assembly. It works as following:

1. **Display boot information:** Firstly, the boot sector display some boot information, when $al = 0$, the null character of boot information hit. Interrupt $0x10$ is used for show a character. Appendix A.1.1 is the code to perform this function.
2. **Read the second sector:** Then jump to load C0-H0-S2, ax register saved the address where beginning puts the sectors from floppy. And preparing parameters for interrupt $0x13$ in registers. The $0x13$ interrupt used for read sector from floppy to memory. Appendix A.1.2 is the code to perform this function.
3. **Read two sides of a track:** If there is a carry, representing some thing wrong when read floppy, so reset the registers and try again read floppy, until five times trying. Register si is a counter. If no carry, jump to next segmentation, as one sector read to memory already, the address space should increase 512 byte. Then sector number(cl register) added 1 and compare it to 18, if it's smaller than 18, jump to $readloop$, read the next sector. If the value of cl register bigger or equal to than 18, meaning that one track 18 sector in this side of floppy read already, then reversed the head, add 1 to dh register. If the value of dh register after adding larger than or equal to 2, it's saying the original head is 1, one track of two sides read already. Otherwise the value of dh register smaller than 2, read this side indicating by dh register, jump to $readloop$ segmentation. Appendix A.1.3 is the code to perform this function.

4. **The next cylinder:** So the next step is moving a cylinder, add 1 to register ch. Otherwise the value of dh register smaller than 2, read this side indicating by dh register, jump to $readloop$ segmentation. After ch register add 1, if it's smaller than 10, jump to $readloop$, otherwise end loading floppy to memory process, for we only load ten cylinders of floppy. Appendix A.1.4 is the code to perform this function.

4.1.4 Running Result

Fig. 4-3 shows the running results of boot loader. From this picture we see that the boot loader loaded 10 cylinders from floppy successfully.

need a better pic.

图 4-3 Running Result of Boot Loader

4.2 32-bit Mode and Import C Codes

4.3 Screen Display and Text

4.4 Control Mouse

4.5 Memory Management

4.6 Making Window

4.7 Timer

4.8 Multitasking

4.9 Command Line Window

4.10 API

4.11 OS Protection

4.12 Graphics Processing

4.13 Window Operation

4.14 Application Protection

4.15 File Operation

4.16 Some Applications

5 Prospects And Shortages

参考文献

[1] 国务院, 中国制造 2025, chinese, **2015-05**.

指导教师简介

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附录 A　Main Program Code

A.1　Boot loader

A.1.1　Display boot information

```
init:
        mov al, [si]
        add si, 1 ; increment by 1.
        cmp al, 0
        je load ; if al == 0, jmp to load, the msg_init info displayed.
; the lastest character is null character, coding in 0.

        mov ah, 0x0e ; write a character in TTY mode.
        mov bx, 15   ; specify the color of the character.
        int 0x10 ; call BIOS function, video card is number 10.
        jmp init
```

A.1.2　Read the second sector

```
load:
        mov ax, 0
        mov ax, 0x0820 ; load C0-H0-S2 to memory begin with 0x0820.
        mov es, ax
        mov ch, 0 ; cylinder 0.
        mov dh, 0 ; head 0.
        mov cl, 2 ; sector 2.
```

```
readloop:
        mov si, 0 ; si register is a counter, try read a sector
; five times.


retry:
        mov ah, 0x02 ; parameter 0x02 to ah, read disk.
        mov al, 1 ; parameter 1 to al, read disk.
        mov bx, 0
        mov dl, 0x00 ; the number of driver number.
        int 0x13 ; after prepared parameters, call 0x13
        ↪  interrupted.
```

A.1.3 Read two sides of a track

```
        jnc next ; if no carry read next sector.
        add si, 1 ; tring again read sector, counter add 1.
        cmp si, 5 ; until five times
        jae error ; if tring times large than five, failed.

        ; reset the status of floppy and read again.
        mov ah, 0x00
        mov dl, 0x00
        int 0x13
        jmp retry


next:
        mov ax, es
        ; we can not directly add to es register.
        add ax, 0x0020 ; add 0x0020 to ax
```

```
        mov es, ax ; the memory increase 0x0020 * 16 = 512 byte.
        ; size of a sector.
        add cl, 1 ; sector number add 1.
        cmp cl, 18 ; one track have 18 sector.
        jbe readloop ; jump if below or equal 18, read the next sector.
        mov cl, 1 ; cl number reset to 1, ready to read the other side.
        add dh, 1 ; the other side of floppy.
        cmp dh, 2 ; only two sides of floppy.
        jb readloop ; if dh < 2, read 18 sectors of the other sides
```

A.1.4 The next cylinder

```
mov dh, 0 ; after finished read the other side, reset head to 0.
add ch, 1 ; two sides of a cylinder readed, add 1 to ch.
cmp ch, CYLS ; read 10 cylinders.
jb readloop
```