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1 CS5600 Week10.a
2
3 1. Two examples of I/O instructions
4
5 (a) Reading keyboard input
6
7 The code below is an excerpt from WeensyOS.
8 (details in PS/2 controller: https://wiki.osdev.org/%22804%22\_PS/2\_Controller)
9 This reads a character typed at the keyboard (which shows up on the
10 "keyboard data port" (KEYBOARD_DATAREG)).
11
12 /* Excerpt from WeensyOS x86-64.h */
13 // Keyboard programmed I/O
14 #define KEYBOARD_STATUSREG 0x64
15 #define KEYBOARD_STATUS_READY 0x01
16 #define KEYBOARD_DATAREG 0x60
17
18 int keyboard_readc(void) {
19     static uint8_t modifiers;
20     static uint8_t last_escape;
21
22     if ((inb(KEYBOARD_STATUSREG) & KEYBOARD_STATUS_READY) == 0) {
23         return -1;
24     }
25
26     uint8_t data = inb(KEYBOARD_DATAREG);
27     uint8_t escape = last_escape;
28     last_escape = 0;
29
30     if (data == 0xE0) { // mode shift
31         last_escape = 0x80;
32         return 0;
33     } else if (data & 0x80) { // key release: matters only
34         // for modifier keys
35         int ch = keymap[(data & 0x7F) | escape];
36         if (ch >= KEY_SHIFT && ch < KEY_CAPSLOCK) {
37             modifiers &= ~(1 << (ch - KEY_SHIFT));
38         }
39         return 0;
40     }
41
42     int ch = (unsigned char) keymap[data | escape];
43
44     if (ch >= 'a' && ch <= 'z') {
45         if (modifiers & MOD_CONTROL) {
46             ch -= 0x60;
47         } else if (!(modifiers & MOD_SHIFT) != \
48             !(modifiers & MOD_CAPSLOCK)) {
49             ch -= 0x20;
50         }
51     } else if (ch >= KEY_CAPSLOCK) {
52         modifiers ^= 1 << (ch - KEY_SHIFT);
53         ch = 0;
54     } else if (ch >= KEY_SHIFT) {
55         modifiers |= 1 << (ch - KEY_SHIFT);
56         ch = 0;
57     } else if (ch >= CKEY(0) && ch <= CKEY(21)) {
58         ch = complex_keymap[ch - CKEY(0)].map[modifiers & 3];
59     } else if (ch < 0x80 && (modifiers & MOD_CONTROL)) {
60         ch = 0;
61     }
62
63     return ch;
64 }
65

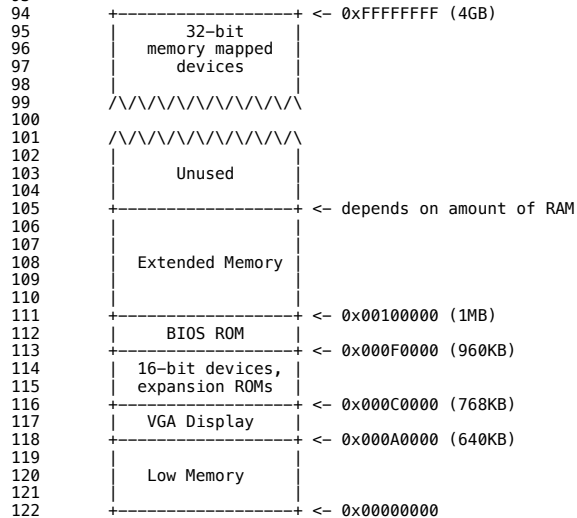
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66
67 (b) Setting the cursor position
68
69 The code below is also excerpted from WeensyOS. It uses I/O
70 instructions to set a blinking cursor. To set the cursor to
71 the upper left of the screen, run: console_show_cursor(0)
72
73 // console_show_cursor(cpos)
74 // Move the console cursor to position 'cpos',
75 // which should be between 0 and 80 * 25.
76
77 void console_show_cursor(int cpos) {
78     if (cpos < 0 || cpos > CONSOLE_ROWS * CONSOLE_COLUMNS)
79         cpos = 0;
80
81     outb(0x3D4, 14); // Command 14 = upper byte of position
82     outb(0x3D5, cpos / 256); // upper byte (256 = 2^8)
83     outb(0x3D4, 15); // Command 15 = lower byte of position
84     outb(0x3D5, cpos % 256); // lower byte
85
86 }
87
88 // if interested, see details: https://wiki.osdev.org/Text\_Mode\_Cursor

```

89
90 2. Memory-mapped I/O
91
92 (a) Here is a 32-bit PC's physical memory map:
93



123 [Credit to Frans Kaashoek, Robert Morris, and
124 Nickolai Zeldovich for this picture]
125
126

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127
128 (b) Loads and stores to the device memory "go to hardware".
129
130 Here is an excerpt of the console printing code from WeensyOS.
131
132
133 /* Compare the address below to the map in panel 2(a). */
134 PROVIDE(console = 0xB8000);
135
136 This is an excerpt about printing; notice how it uses the address
137 "console":
138
139 /*
140 * prints a character to the console at the specified
141 * cursor position in the specified color.
142 * Question: what is going on in the check
143 * if (c == '\n')
144 * ?
145 * Hint: '\n' is "newline" (the user pressed enter).
146 */
147 static void console_putc(printer* p, unsigned char c, int color) {
148     console_printer* cp = (console_printer*) p;
149     if (cp->cursor >= console + CONSOLE_ROWS * CONSOLE_COLUMNS) {
150         cp->cursor = console;
151     }
152     if (c == '\n') {
153         int pos = (cp->cursor - console) % 80;
154         for (; pos != 80; pos++) {
155             *cp->cursor++ = ' ' | color;
156         }
157     } else {
158         *cp->cursor++ = c | color;
159     }
160 }
```