ECE 471 – Embedded Systems
Lecture 29

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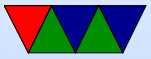
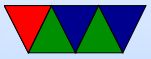
Announcements

- HW#9 was due
- You can start turning in parts now (assuming you don't need them for your project)
- Talk today in 228 Barrows 2pm
- Project status report due Monday. Not long:
  - A one-line statement of your project topic
  - A short summary of the progress you've made so far
  - List any parts you need that you don't have yet
  - List if you're willing to present early (Friday the 6th,

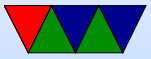


Monday 9th or Wednesday 11th vs Friday the 13th)
(there will be some bonus for presenting early)



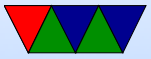
Homework 8 – Code

- Pre-processor does not work in quotes, want `SENSOR_NAME` not `"SENSOR_NAME"` when opening
- Error checking. Exit if cannot open. If you don't, can segfault if try to fscanf a NULL FILE*
- What to report on error? What's an invalid temperature? Not just unlikely? (Below Absolute zero)
- Be sure to close files, otherwise leak file descriptors Eventually you will run out



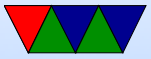
Starting Programs at Boot

- init process starts first
- Traditionally would start various shell scripts under /etc (the name and order of these can vary a lot)
- Possibly with advent of systemd this will change
- Currently you can still put things you want to run at start in `/etc/rc.local`



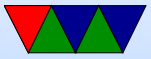
Wii Nunchuck

- Fairly easy to interface
- Put onto i2c bus. Device 0x52
- Send handshake to initialize. Use longer one (0xf0/0x55/0xfb/0x00) not the simpler one you might find(0x40/0x00). This works on generic nunchucks and possibly also disables encryption of results.
- To get values, send 0x00, usleep a certain amount, and read 6 bytes. This includes joy-x, joy-x, accelerometer



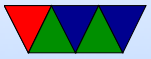
x/y/z and c and z button data. More info can be found online.

byte0 = joy-x, byte1 = joy-y, byte2 = top8 acc x, byte3 = top8 acc y, byte4 = top8 acc z, byte 5 is bottom 2 z,y,x then button c and z (inverted?)

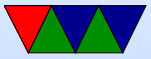


Linux and Keyboard

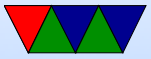
- Old ps/2 keyboard just a matrix of keys, controlled by a small embedded processor.
  Communication via a serial bus. Returns "keycodes" when keypress and release and a few others.
- Many modern keyboards are USB, which requires full USB stack. To get around needing this overhead (for BIOS etc) support bit-bang mode. OS usually has abstraction layer that supports USB keyboards same as old-style



- Linux assumes "CANONICAL" input mode, i.e. like a teletype. One line at a time, blocking input, wait until enter pressed.
- You can set non-CANONICAL mode, async input, and VMIN of 1 to get reasonable input for a game. Arrow keys are reported as escape sequences (ESCAPE-[-A for up, for example).
- Even lower-level you can access "RAW" mode which gives raw keycode events, etc.
- See the `tcgetattr()` and `tcsetattr()` system calls
- There are libraries like ncurses that abstract this a bit.

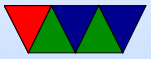


Also GUI and game libraries (SDL).



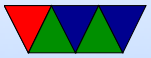
Faking Linux Input Events

- How to insert input events into Linux, i.e. have a software program fake keyboard/mouse/joystick events.
- Linux supports a "uinput" kernel driver that lets you create user input.
- There is some info on a library that makes this easier here: `http://tjjr.fi/sw/libsuinput/`
- It has examples for keyboard and mouse. Joystick should be possible but there's no sample code provided.
- Python wrappers seem to exist too.

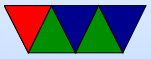


Camera Port

- The SoC has dedicated hardware for driving cameras
- 5megapixel, CSI port (Camera Serial Interface) plus i2c bus to command it.
- Can read data in parallel, directly, without needing USB overhead.
- These chips often used in cell-phones, so makes sense to have support for camera-phone without extra chip being needed.

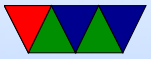


Touchscreen Display Port

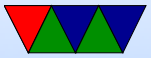


UART – serial port

- Note: Asynchronous, no clock (unlike USART) how do both sides agree on speed?
- Often useful on embedded boards and old systems, might be only way to reliably connect
- RS-232, originally for teletypes
- 3-15V high, -3 to -15V low
- start/stop bits, parity, bit-size
- Hardware vs Software flow control
- Speeds 300bps - 115000bps and beyond

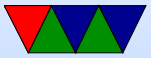


- 50feet (15m) w/o special cables
- 3-pin version (transmit, receive ground). Also 5-pin HW flow control (CTS/RTS). Can have 2-pin version if only want to transmit
- These days often hook up USB connector
- What does 9600N81 mean?



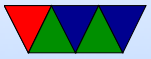
Pi Serial Ports

- Raspberry Pi has two serial ports, good one and lousy one
  They switched them up with Pi3
- Pi does TTL (5v/0) not RS232
- Does support HW flow control, but need to activate those pins custom, is a bit complicated
- Use TTL to USB serial converter usually.
  Tell story of the prolific bricking the firmware?

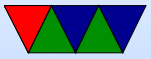


Bluetooth

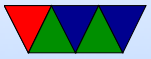
- Basic unit: piconet, master node and up to seven *active* slave nodes within 10m
- Many can exist in an area, and can be connected by a bridge. Connected piconets are called a scatternet
- There can also be up to 255 “parked” nodes in a picnoet
- When parked, can only respond to activation on beacon
- Hold and siff?
- Slaves designed to be cheap, so dumb. Master is smart and runs them. slave/slave communication not possible



- Master broadcasts clock 312.5us. Master transmits in even, slave in odd.
- Radio layer – 2.4GHz, 10 meters. 79 channels of 1MHz.
- pairing
- Bluetooth V1.1 has 13 different application protocols.
- Bluetooth 4.0 (Bluetooth Low Energy) (2010)
  - 25Mbps/200 feet
  - Entirely new stack, designed for low power rapid setup links
  - Not backwards compatible, but same frequency range
  - New profiles



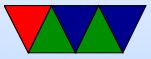
- Linux interface: depends on type. Filetransfer/obex. Audio (looks like an audio driver) network device, serial device



Bluetooth and Linux

- Two competing stacks, BlueZ and Affix

```
sudo bluetoothctl
[sudo] password for vince:
[NEW] Controller B8:27:EB:52:DD:E8 linpack-test
[bluetooth]# power on
Changing power on succeeded
[bluetooth]# scan on
Discovery started
[CHG] Controller B8:27:EB:52:DD:E8 Discovering:
```



```
[NEW] Device AC:37:43:89:4C:02 HTC BS 02CA47
[NEW] Device AC:37:43:89:2F:86 HTC BS 86B06E
[CHG] Device AC:37:43:89:2F:86 RSSI: -90
[bluetooth]# scan on
Failed to start discovery: org.bluez.Error.InPr
[bluetooth]# connect AC:37:43:89:4C:02
```

- obexpushd. Appears as serial port?