

ECE 471 – Embedded Systems

Lecture 32

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Announcements

- Don't forget HW#10 (Power)
Due Friday. Might not have time to go over in class but will post solutions
- Working on grading HW#9, will go over Wednesday
- Remember to return parts
- Course Evals
- Hand back midterms. Average was around a 92 or so



Project Update

- Sent out tentative project schedule. Note can change date within reason. Also the order by day is arbitrary, usually I ask for volunteers
- Project: minor update to project presentation/report
- Note added Ethics part. If need help with ethics, can check IEEE ethics statement <https://www.computer.org/education/code-of-ethics>
- Aim for about 7 minutes (5 presentation+ 2 demo)
- Will give example presentation Wednesday



Other I/O You'll find on Embedded Boards



SD/MMC

- MultiMediaCard (MMC) 1997
- Secure Digital (SD) is an extension (1999)
- SDSC (standard capacity), SDHC (high capacity), SDXC (extended capacity), SDIO (I/O)
- Standard/Mini/Micro sizes
- SDHC up to 32GB, SDXC up to 2TB
- Support different amounts of sustained I/O. Class rating 2, 4, 6, 10 (MB/s)
- Patents. Need license for making.



SD/MMC Hardware Interface

- 9 pins (8 pins on micro)
- Starts in 3.3V, can switch to 1.8V
- Write protect notch. Ignored on pi?



SD/MMC Software Interface

- SPI bus mode
- One bit mode – separate command and data channels
- Four-bit mode
- Initially communicate over 1-bit interface to report sizes, config, etc.
- DRM built in, on some boards up to 10% of space to handle digital rights



SDIO

- SDIO – can have I/O like GPS, wireless, camera
- Can actually fit full Linux ARM server on a wireless SDIO card



eMMC

- eMMC = like SD card, but soldered onto board



More Embedded Board Busses/Interfaces



Camera Port

- The SoC has dedicated hardware for driving cameras
- 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.
- Might need to use special tool to get still images (mmal



interface), until recently not using more common video-4-linux API



Camera Models

- 2013 – 5 Megapixel
- 2016 – 8 Megapixels (Model2)
- 2023 – 12 Megapixels (Model3) (wide/narrow versions)
- NoIR – infrared filter removed so can take IR images
- GS – Global (vs rolling) shutter version



Touchscreen Display Port

- DSI
- Touchscreen display that can make a Pi look sort of like a smartphone
- GPU can output to it directly



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

- Pi originally had two serial ports: good one and lousy one
They switched them up with Pi3 (due to bluetooth)
- Pi4 adds a bunch more of them
- 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.



Pi SMI

- <https://iosoft.blog/2020/07/16/raspberry-pi-smi>
- Secondary Memory Interface
- Available on Pis
- Allows creating wide parallel bus out of GPIOs
- Not well documented

