

EE 193: Advanced Embedded Systems

Steven Bell

1 February 2024

Logistics

Order your PCB if you haven't already

I'll be submitting the parts order tonight

Roadmap

Today: The fundamental theorem of microcontrollers

Tuesday: Getting started with the ESP32

Beyond: GPIO, ADCs, and digital protocols

Don't use Arduino (for professional work)

Licensing

choosealicense.com

For this course, you may use open-source code.

BUT it must be under a license that lets you use it commercially (without releasing source code).

Don't use Arduino (for professional work)

Cost

Actual development environment + debugger

Arduino hides lots of things that matter in favor of "magic"

Arduino magic

Where is `main`???

And where did `setup` and `loop` come from?

Don't even get me started on libraries...

Let's go digging in `$INSTALL/hardware/avr/cores/arduino`

Inside digitalWrite()

How fast will this toggle the pin (in Hz/kHz/MHz)?

```
while(1) {  
    digitalWrite(13, HIGH);  
    digitalWrite(13, LOW);  
}
```


Moral of the digitalWrite() story

Write your own bare-metal code because libraries are slow.

Moral of the digitalWrite() story

~~Write your own bare-metal code because libraries are slow.~~

NO! NO! NOOO!

The real problem is that programmers have spent far too much time worrying about efficiency in the wrong places and at the wrong times; **premature optimization is the root of all evil** (or at least most of it) in programming.

- Donald Knuth, The Art of Computer Programming

Moral of the digitalWrite() story

There's no magic, just pointers all the way down

The "fundamental theorem" of microcontrollers

1) Peripherals are memory-mapped

The "fundamental theorem" of microcontrollers

- 1) Peripherals are memory-mapped
- 2) and operate independently of the main processor

What if we wanted to do better PWM?

For Tuesday

Read "The Amazing \$1 Microcontroller",
or listen to the podcast linked on the course website