Embedded Programming with Rust

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This talk

1. DEMO!
2. What is embedded programming?
3. Demo Hardware
4. No OS!
5. Code compilation
6. Uploading a program
7. Wrap Up

DEMO!

To the demo…
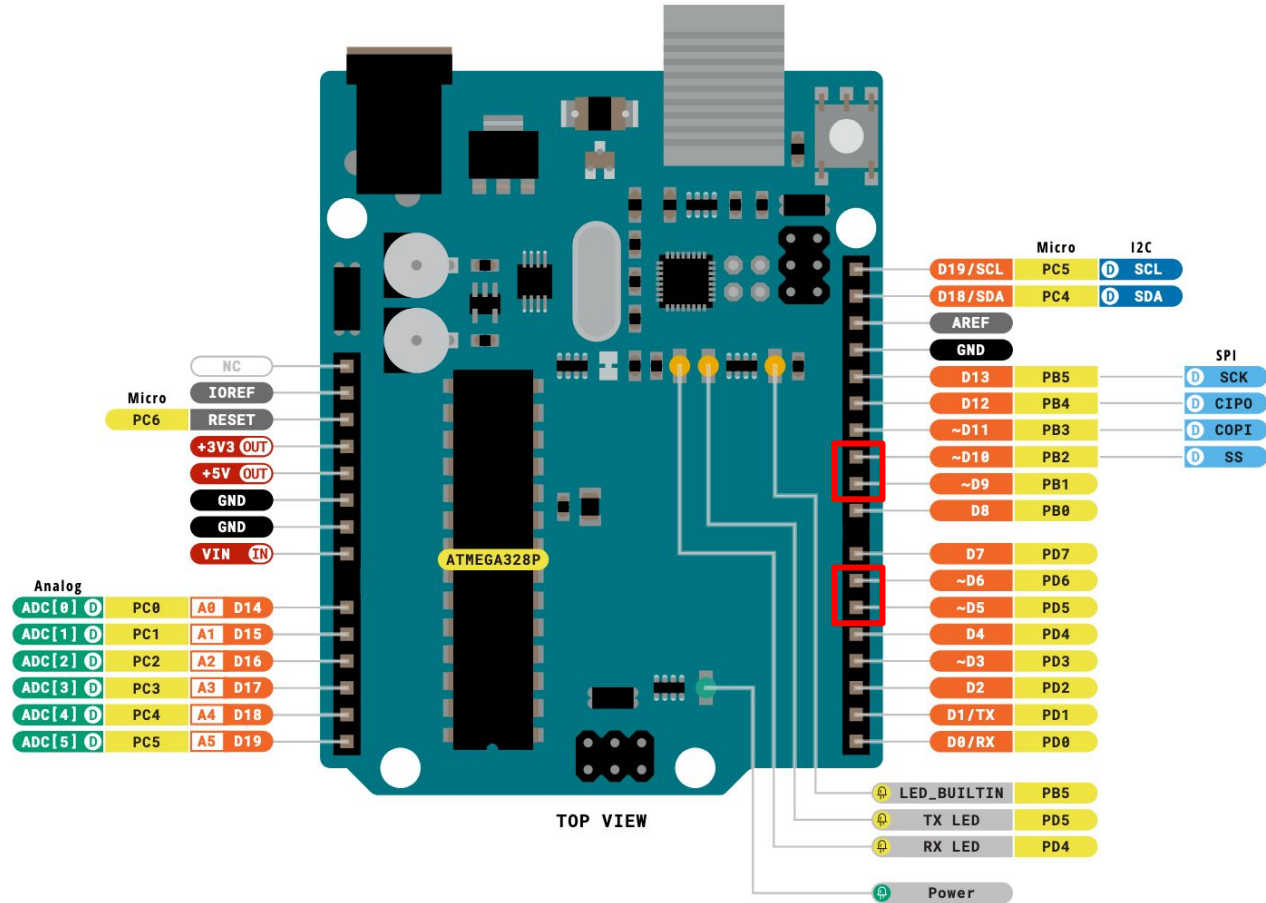
What is Embedded Programming?

Wikipedia:

> Embedded software is computer software, written to control machines or devices that are not typically thought of as computers [...]. It is typically specialized for the particular hardware that it runs on and has time and memory constraints.
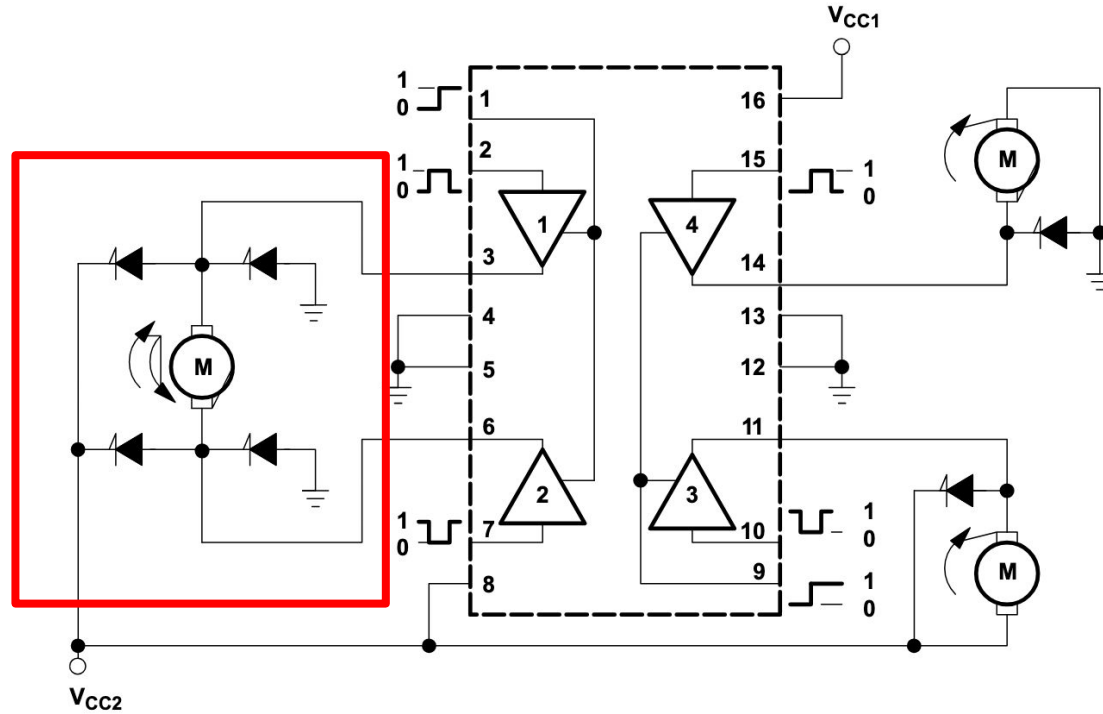
Hardware

- [Arduino Uno R3](#)
- [Motor Driver L293D](#)
- 3V - 12V DC Motor, 25000 RPM

Arduino

Motor Drivers

Output diodes are internal in L293D.

LED Blink Program

```rust
#![no_std]
#![no_main]

use panic_halt as _;

#[arduino_hal::entry]
fn main() -> ! {
    let dp = arduino_hal::Peripherals::take().unwrap();
    let pins = arduino_hal::pins!(dp);

    let mut led = pins.d13.into_output();

    loop {
        led.toggle();
        arduino_hal::delay_ms(500);
    }
}
```

And BTW, there's no Operating System

- #![no_std]
  - [Use core](#)

- #![no_main]
  - Arduino requires a special entry point, so we disable "main"

- [use panic_halt as _;](#)

Arduino CPU: Atmega328p

- PC: x86_64 or aarch64

- Atmega328p
  - Sold by Microchip
  - https://www.digikey.ca/en/products/filter/microcontrollers/685?s=N4IgTCBcDaIIYBcC2BTA5nAzGAHABxAF0BfIA

- Godbolt Example

Cross Compilation

- Toolchains
  - We need to have the correct toolchain installed for our CPU
  - [Supported Platforms](#)
- Tools for producing output binaries
  - https://github.com/Rahix/avr-hal?tab=readme-ov-file#quickstart
- Rustup
  - Can be used to install toolchains for supported platforms
  - Rustup target add <TARGET>
- .cargo/config.toml
  - Save target information for a repository
- Other tools to analyze
  - file
  - nm

Uploading the program to the Arduino

- Manual
  - Avrdude
  - `avrdude -c arduino -P /dev/tty.usb -b 115200 -p atmega328p -D -U flash:w:target/avr-atmega328p/release/arduino-led.elf`

- Automatic
  - Ravedude - Acts as a "cargo runner", meaning cargo uses this tool when you type "`cargo run`"

Code Concepts

- Embedded-hal
  - InputPin
  - OutputPin

- Pulse Width Modulation (PWM)
  - DutyCycle

Resources for Embedded Programming with Rust

- The Embedded Rust Book: https://docs.rust-embedded.org/book/

- Rustnomicon: https://doc.rust-lang.org/nomicon/

- Crates
  - Embedded-hal - hardware abstraction layer interfaces
  - Embassy - Async code in embedded environments
  - Heapless - std data structures but without heap allocations

- List of cool Rust embedded libraries/projects