CprE 288 – Introduction to Embedded Systems
(Lab 3 Overview)

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Lab 3

• Overview of hardware
  – Push Buttons (Switches)
  – Shaft Encoder (Control Knob)
  – Stepper Motors
Lab 3 Memory-Mapped I/O

Now write your own API functions for I/O devices

Part I. Push button
   To detect which buttons are being pushed

Part II. Shaft Encoder
   To take input of a shaft and emulate its behavior

Part III. Stepper Motor
   To control motor movement precisely
Part I. Push button

Return the position of the leftmost button that is being pressed. The rightmost button is position 1. Return 0 if no button is being pressed.

```c
char read_push_buttons(void);
```

Six push buttons, connected to PINC bits 5–0
Active low – if a button is pushed, the corresponding bit is 0, otherwise 1
Lab 3 Memory Mapped I/O

Q1: How does it work mechanically and electronically?

Q2: How to read the raw input from the push buttons?

Q3: How to read a port?
Part II. Shaft Encoder

- The device generates two waveforms to two input pins of ATmega128 (PC6 and PC7)
- The direction of the shaft encoder is reflected by the ordering of the two waveforms
- A leading B is clockwise, B leading A is counter-clockwise
- Channel B connected to PINC bit 7, Channel A connected to PINC bit 6
Q1: How does your program read and represent the waveform?

Q2: How do you decide the ordering of the waveform, i.e. A leads B or B leads A?
Stepper Motor (Wikipedia)

- Full rotation divided into multiple steps.
- Motion is controllable one step at a time without need for feedback.
- Four coils giving four magnetic axes.
Stepper Motor Control

- 200 steps per $360^\circ$: $1.8^\circ$ per step.
- 0001 -> 0010 -> 0100 -> 1000 -> 0001 -> ....
- 0001 -> 1000 -> 0100 -> 0010 -> 0001 -> ....
Part III. Stepper Motor

To rotate clockwise: send to PE7-PE4 the following sequence: 0001, 0010, 0100, 1000, 0001, ...

Allow 2ms gap between two outputs
Lab 3 Memory Mapped I/O

Q1: How to rotate the four bits?

Q2: How to send out the four bits to PE7-PE4 without affecting the other four bits of PORTE?

Q3: How to couple the shaft encoder with the stepper motor?