Facultat d'Informàtica de Barcelona
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Real-Time Systems

3-LAB motor position control

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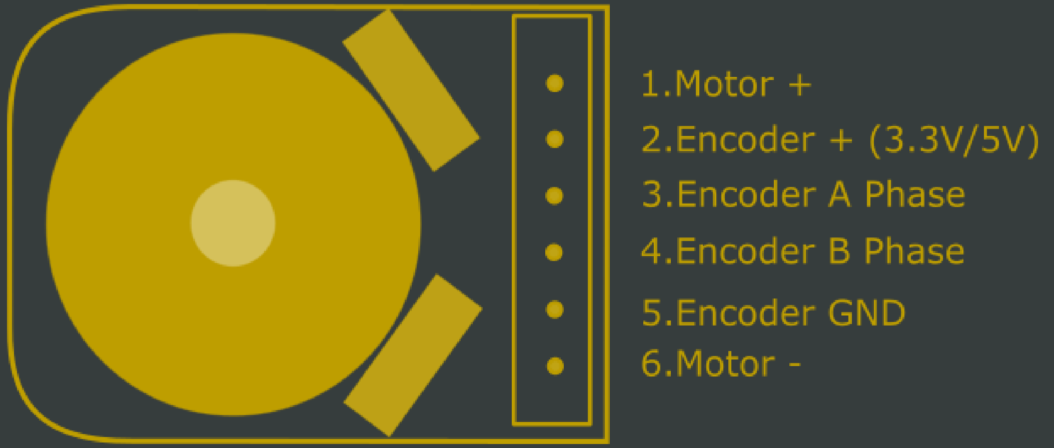
Lab 3 motor position control

The main objective is to control the position of a FIT0482 dc motor.
The motor should move in steps from +90º to -90º each second.
Motor is powered by an arduino motor shield rev3
Motor position is obtained based on a quadrature encoder (7*2*2*50 pulses/revolution). 7 because there are such a number of metallic parts rotating, 2*2 because we are using quadruple precision (i.e. rising and falling interrupts), and 50 because of the gear. Details about encoders can be seen in this video

To control the motor position, a Proportional-Integral-Derivative (PID) controller is recommended

Connect the motor as follows:

Motor power 5Vdc (red) to motor shield A+
Power to hall sensors (black) to 5V
Hall sensor A (yellow) to pin 18
Hall sensor B (green) to pin 19
GND to hall sensors (blue) to GND
Motor ground (white) to motor shield A-



Send code to the raco. For each task, provide the WCET as a comment at the beginning of the task.

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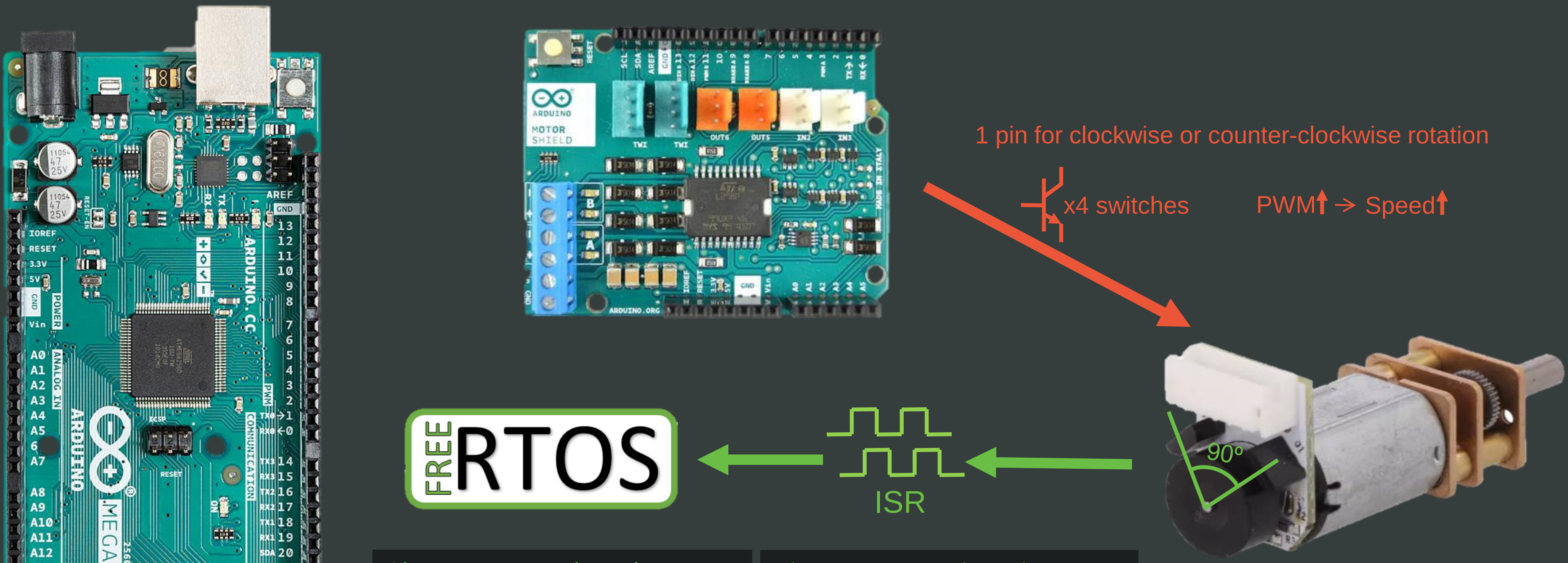

1 pin for clockwise or counter-clockwise rotation

x4 switches

PWM↑ → Speed↑

FREE RTOS

ISR

```
Change on EncoderAPin:
    if pinEncoderA=pinEncoderB
        counter:=counter+1
    else
        counter:=counter-1
```

```
Change on EncoderBPin:
    if pinEncoderA=pinEncoderB
        counter:=counter-1
    else
        counter:=counter+1
```

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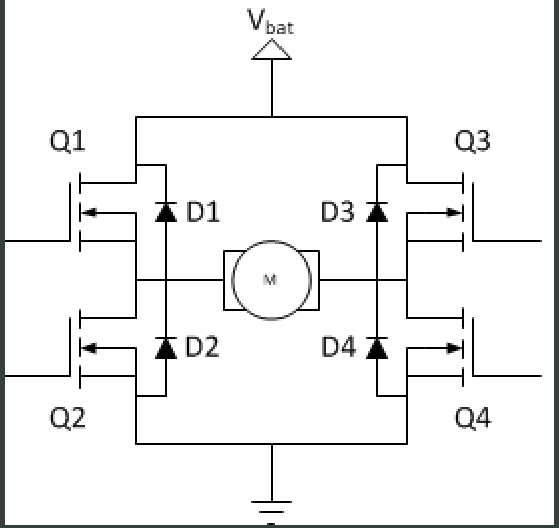
How the dc-motor works:



Powering the dc-motor is performed by 4 switches (transistor based)

1001 rotates motor clockwise

0110 rotates motor counter-clockwise

other combinations does not rotate

pin 12 selects between first and second options (i.e direction)

by using AnalogWrite to pin 3, it is possible to regulate the duty-cycle of each switch, and thus its effective voltage (related to the rotation speed)

Sensing the position

2 hall-effect sensors detect a pulse when a piece of metal pass close to them due to the rotation of the motor. Use of pinMode(17 and 18,INPUT_PULLUP) at setup is required

depending on the measurement, it is possible to detect clock or counter-clock wise rotation

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Step 0: tasks design!!! How many, which functionality, which priority, is there any precedende, …

Step 1: test PWM output value on pin 3 to change motor speed

Step 2: test motor direction based on pin 12 to change rotating direction

Step 3: get motor position from the encoder

Step 4: plot data

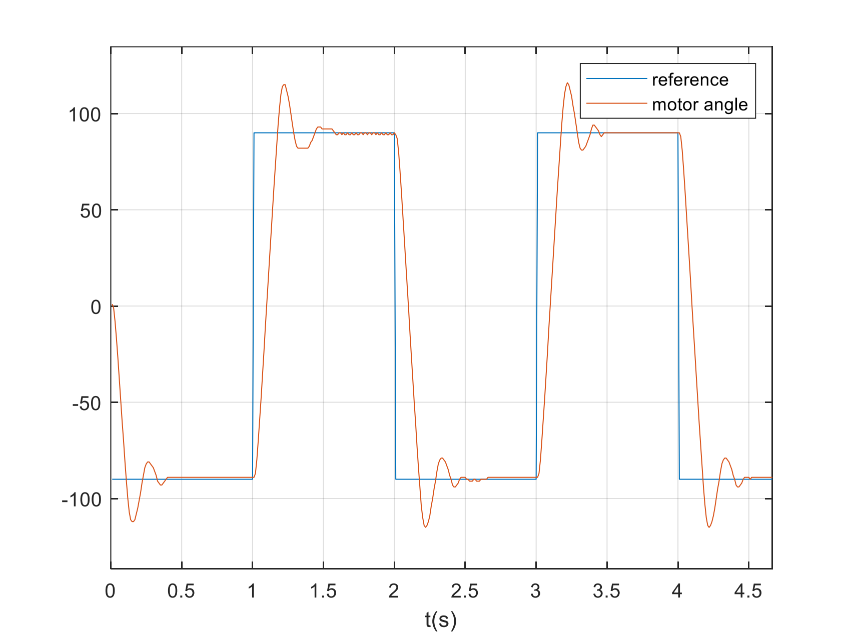
Step 5: create a variable reference changing from

+90º to -90º each second

Step 6: close the loop with a PID feedback controller

in order to make the output motor position to follow

the reference value. This loop should execute each 10 ms.



Step 7: fine tuning of the controller gains to make the system behave fast and smooth

Step 8: change the reference from +90º/-90º to the roll angle of the IMU sensor, and later to the distance from the TimeOfFlight sensor

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-The lab activity will last 3 weeks (some homework is required to finish everything before its deadline)

-Zip all the project folder and send it to the raco

-For each task, add a comment at the beginning of the task summarizing its worst case execution time, how it has been computed and some alternatives to better compute it

-Please, use the rs232_r1.m file to plot the data from matlab. Or even better, develop a custom tool to visualize data! It will be rewarded with a higher mark