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School of Mechanical Engineering
College of Engineering
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Mechatronics Lab Manual

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SESSION #6

DC Motor & Encoder (Part 1 - Encoder)

Mechatronics

Lab Manual

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Session Objectives

- Measuring rotational velocity.

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Introduction to TA

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Thanks to:

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1. Quadrature Encoders

Quadrature Encoders are handy sensors that let you measure the speed and direction of a rotating shaft (or linear motion) and keep track of how far you have moved.

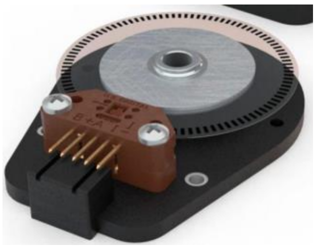

Figure 1: Quadrature encoder

A quadrature encoder normally has at least two outputs (Channel A and B) each of which will produce digital pulses when the disk rotates. These pulses will follow a particular pattern that will show the rotation direction, and by measuring the time between pulses, or the number of pulses per second, you can also derive the speed. They have a series of grooves wheel inside the wheel rim, and the PCB has a pair of sensors that point at the wheel, sending signals when a groove is placed in front of them. These sensors have just the right spacing between them, and relative to the grooves on the wheel.

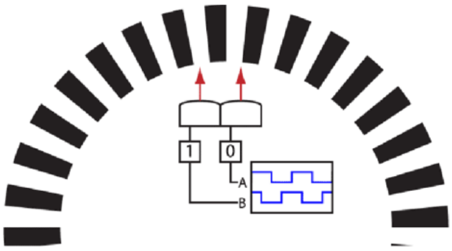

Figure 2: Working mechanism of a quadrature encoder

In technical terms these pulses are 90 degrees out of phase meaning that one pulse always lead the other pulse by one quarter of a complete cycle (a cycle is a complete transition from low >high > low again. The order in which these pulses occur will change when the direction of rotation changes. The two diagrams below show what the two pulse patterns look like for clockwise and counter clockwise rotation.

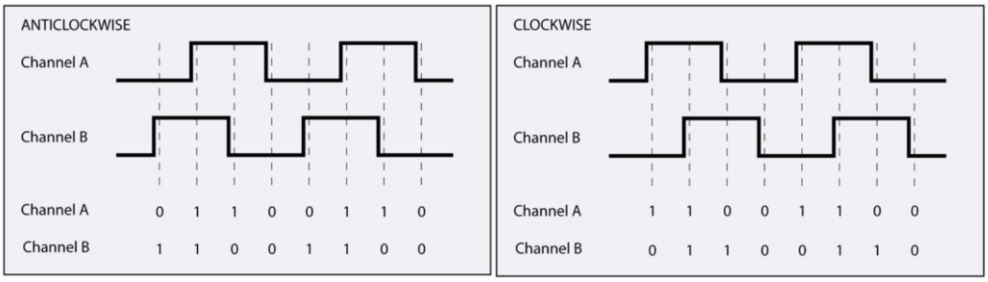

Figure 3: Signals of the encoder

So how do you actually work out the direction?

- Let's start with channel A at the top (clockwise rotation):

  Channel A goes from LOW to HIGH

  Channel B is LOW!

  You are going CLOCKWISE!

- Now take a look at channel A when going counter clockwise:

  Channel A goes from LOW to HIGH

  Channel B is HIGH

  You are going COUNTER-CLOCKWISE!

1.1. Velocity Measurement

To obtain velocity, we need two variables: first, the number of pulses (amount of distance the shaft rotated) and second, the duration of it. Encoder speed can be determined by either of two methods: pulse counting (constant Δt) or pulse timing (constant Δpos). The former is used for high speeds and is less accurate, whereas the latter is used for low speeds and offer more accuracy.

$$RPM = \frac{60N}{N_e \times T}$$

Where N is the number of counted pulses in T seconds and Ne is the pulses of the encoder in one rotation.

Task

1- Interface the encoder with Arduino by using hardware interrupt. (Count the pulses)

2- Connect the motor to the power supply (24 Volts). Change the direction of the motor by inverting the polarity of the voltage and see if your code detects this.

3- Calculate the velocity of the motor. Change the speed by varying the input voltage and see the effect.