

# SENSORS AND ACTUATORS

## STEPPER MOTOR

*Laboratory Guide*

### IDENTIFICATION

Weekday	Date	Hour	Group	Students
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### INTRODUCTION

A stepper motor is used to make things move. This movement can aim to change the position of the load or give it a given speed or acceleration. There are several forces that naturally oppose the change of position or speed of a body, including inertia, friction, gravity, the force of a spring, etc. It is therefore necessary that a motor can exert sufficient torque to overcome these other forces that may be acting on the load. In general, the motors used are rotary motors, i.e., the bodies are rotated around a fixed axis. When one wishes to have a linear movement, one often uses a rotary motor and a mechanical device that turns this movement into a linear movement. An example is the automobile. The rotation of the automobile engine which makes the wheels rotate is transformed into a translational movement by the friction of the wheels with the asphalt.

A stepper motor is distinguished from other motors to the extent that the movement of rotation is not uniform. In DC or AC electric motors, for example, the applied voltage is proportional to the rotation speed. If the voltage is constant the rotational speed will remain constant as well. If you wish to have a given acceleration to a body, you just increase linearly the voltage applied. If the goal, however, is the position of a body in a certain position using these types of motors, then a more complex control circuit is required together with a sensor that indicates the position of the body. The control circuit uses this information to increase or decrease the voltage applied to the motor until the desired position is reached. A closed loop control system is required.

It's exactly in applications where it is desired easy positioning of a body that stepper motors are used. The control of these motors is simpler in that it can operate in open loop.


Stepper motors are constructed in such a way that the motion of the axis (rotor) occurs in well-defined steps, i.e., each time it "sends a command" to the motor it rotates by a fixed amount. In a stepper motor with a step of  $7.5^\circ$  where one wants to turn the rotor by  $30^\circ$  one just send this "command" 4 times to produce 4 steps.

*Recommended reading:* Book Sensors and Actuators by Francisco Alegria, section 5.4.

## EXECUTION

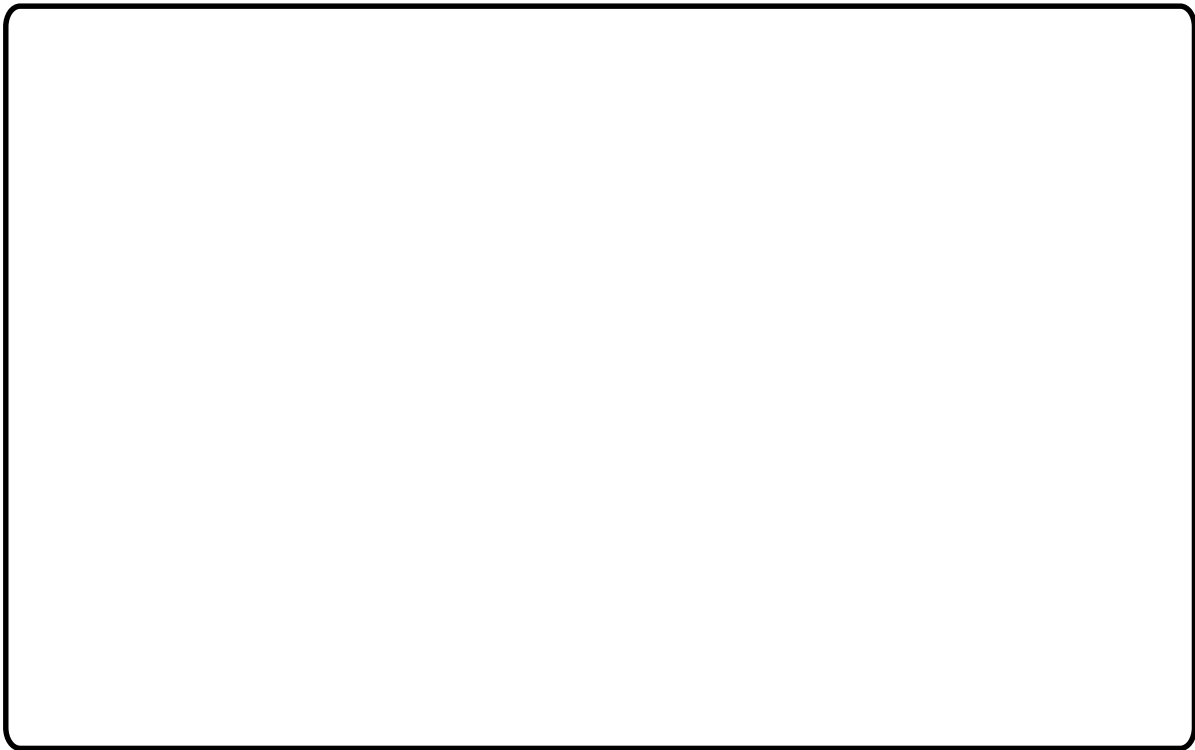
### *1) Motor Control System*

Devise a system of control of the stepper motor using the ULN2003A integrated circuit that contains a set of transistors in Darlington assembly and the Arduino Uno microcontroller. Build it and present your wiring diagram.



### *2) Control Application Development*

Develop an application using the Arduino IDE that allows you to control the position of the motor rotor (number of steps in an absolute reference frame). Present the flowchart for the application.



### 3) *Number of Motor Steps*

What is the number of **full steps** that the motor assembly has?

### 4) *Conclusions*

Draw some conclusions about the project carried out including, for example (but not limited to), comments on the positioning accuracy of the stepper motor, speed of rotation and relevance of the use of a gearbox.

## **MATERIAL**

### 1) *Components*

- 1 stepper motor
- 1 integrated circuit ULN2003A which has a set of transistors in a Darlington assembly
- 1 Arduino Uno microcontroller