ECE 271 Microcomputer Architecture and Applications
Lab 4: Stepper Motor Control
Instructor: Prof. Yifeng Zhu
Spring 2015

Goals

1. Understand the limitation of GPIO output current
2. Learn to use Darlington transistor arrays to perform high-current driving with extremely low input current
3. Understand the usage of full stepping and half stepping to control the speed and position of a stepper motor
4. Gain experience of generating of pulse waveforms to control a stepper motor

Pre-Lab Assignment

1. Read the textbook Chapter 16 Stepper Motor
2. Watch video tutorial: How the Stepper motors are made and how they operate (Credit goes to *pcbheaven*)
    a. Part 1 (5 minutes): http://www.youtube.com/watch?v=MHdz3c6KLrg
    b. Part 2 (8 minutes): http://www.youtube.com/watch?v=t-3VnLadIbc
3. Answer the pre-lab questions

Lab Requirements

1. Basic requirement: Turn the stepper motor exactly 360 degrees clockwise by using half-stepping and full-stepping
2. Something cool. The following provide some examples.
    a. Use the keypad to set a specific degree to which the motor should rotate.
    b. The motor should smartly choose either clockwise or counter-clockwise to make a minimum amount of rotation.
    c. Display the degree and turning direction of the motor in real time.
    d. Perform micro-stepping to rotate the motor smoothly
    e. Something really cool!

Stepper Motors

- Motor 1: Mabuchi #PF35T
    - The motor has two phases and 48 steps per revolution, *i.e.* 7.5 degrees per step.
    - The rotor has 10 teeth.
- Motor 2: Nippon Pulse #PF55-48D
    - 55mm diameter x 25mm 5V unipolar stepper motor.
    - 7.5 Degrees per step. 2-phase.
    - 5 Ohms per phase.
    - Six 12" leads.
- Motor 3: Airpax # LA82126-M6 (8628)
    - 25mm diameter x 13mm body
    - 12V, 65Ω coil.

- 15° step angle
- Six 4" leads.

Connection Diagram

There are only five pins that are freely available to users on the discovery kits (PA 5, PA 11, PA 12, PC 12, and PD 2). The following pins have been used in the keypad lab:

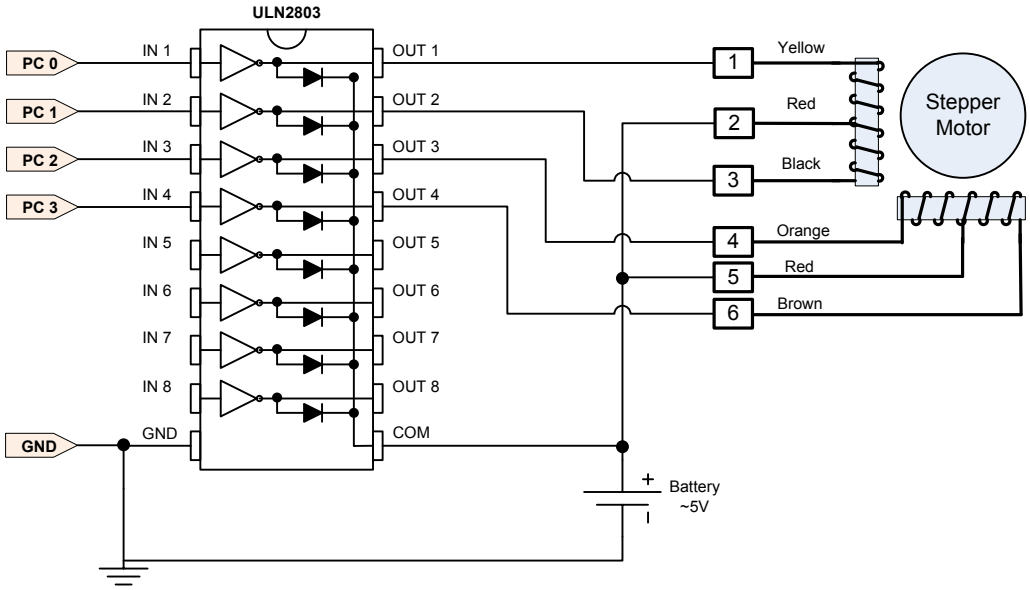
Keypad Row Pins	R1 → PA 5	R2 → PA 11	R3 → PA 12	R4 → PA 15
Keypad Column Pins	C1 → PB 8	C2 → PB 13	C3 → PB 14	C4 → PB 15

Interfacing the stepper motor requires four pins. We select the following four pins to control the stepper motor: **PC 0**, **PC 1**, **PC 2**, and **PC 3**. Note that the last three digits (digit 4, 5, and 6) of the LCD cannot display correctly.

The textbook provides a connection diagram for stepper motor 1 (Mabuchi #PF35T).

For stepper motor 2 (Nippon Pulse #PF55-48D), the connection diagram is the same as stepper motor 1 except that two red wires should be connected to +5V.

For stepper motor 3 (Airpax # LA82126-M6), the following is the connection diagram.



Extend the battery life

The stepper motor can draw a large current and drain the batteries quickly if the motor turns too slow. A relatively small loop delay should be used to avoid turning the motor too slow.

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Name: _____

Pre-Lab Question

1. How to change the rotation speed of a stepper motor?

2. How to reverse the rotation direction?

Lab Demo Requirements

1. Rotate your stepper motor exactly 360 degrees either clockwise or counter-clockwise.
2. What is the highest update frequency of the full-stepping control signals while the motor does not drop any steps? Use an oscilloscope to find out your update frequency.
3. What is the highest update frequency of the half-stepping control signals while the motor does not drop any steps? Use an oscilloscope to find out your update frequency.
4. Is the highest update frequency of the half-stepping higher than full-stepping? Why?

Post-lab Assignments

1. Last year, one group of students used the stepper motors used in this lab to build a robotic car. However, they found that the motors did not have enough torque to move the car. What solution you could have?
2. The Darlington array has only 500-mA rated collector current. If you need a larger current, what option you can have to replace the Darlington array.