MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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LAB MANUAL 6

Stepping Motor Control

Introduction

The stepping motor is a device which can transfer the incoming pulses to stepping motion of a predetermined angular displacement. By using suitable control circuitry, the angular displacement can be made proportional to the number of pulses. Using microcomputer, one can have better control of the angular displacement resolution and angular speed of a stepping motor. Stepping motors are suitable for translating digital inputs into mechanical motion.

Theory of Operation

Stepper motors operate differently from normal DC motors, which simply spin when voltage is applied to their terminals. Stepper motors, on the other hand, effectively have multiple "toothed" electromagnets arranged around a central metal gear. To make the motor shaft turn, first one electromagnet is given power, which makes the gear's teeth magnetically attracted to the electromagnet's teeth. When the gear's teeth are thus aligned to the first electromagnet, they are slightly offset from the next electromagnet. So, when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one, and from there the process is repeated. Each of those slight rotations is called a "step."

In that way, the motor can be turned a precise angle. The step angle for each step depends on the number of teethes on the rotor and pole faces. Stepper motors are mostly Hybrid type. In this experiment we will use a hybrid stepper motor with full step angle of 1.80 and half step angle of 0.90.

Single-phase excitation

The stepping position will be 0°,1.8°, 3.6°, ... 358.2°, total 200 steps in one round.

Table 1 Full step truth table (One coil excitation)

Full Step Motion → Single coil excitation							
STEP	B2 (Coil 4)	A2 (Coil 3)	B1 (Coil 2)	A1 (Coil 1)	Byte	Forward	Reverse
1X	0	0	0	1	1	↓	↑
2X	0	0	1	0	2		
3X	0	1	0	0	4		
4X	1	0	0	0	8		

Two-phase excitation

The stepping positions will be 0.9°, 2.7°, 4.5°, ... 359.1°, total 200 steps in one round.

Table 2 Full step truth table (two coil excitation)

Full Step Motion → Two coil excitation							
STEP	**B2 (Coil 4)**	**A2 (Coil 3)**	**B1 (Coil 2)**	**A1 (Coil 1)**	**Byte**	**Forward**	**Reverse**
1Y	0	0	1	1	3	↓	↑
2Y	0	1	1	0	6		
3Y	1	1	0	0	12		
4Y	1	0	0	1	9		

Single-phase and two-phase excitations combined

The stepping positions will be 0°, 0.9°, 1.8°, 2.7°, 3.6°, 4.5°, ...358.2°, 359.1°, total 400 steps in one round. Since stepping motor makes step -by-step movement and each step is equidistant, the rotor and stator magnetic field must be synchronous. During start-up and stopping, the two fields may not be synchronous, so it is suggested to slowly accelerate and decelerate the stepping motor during the start-up or stopping period.

Table 3 Truth table for operating a stepper motor in wave motion (Half step operation)

Wave (half Step) Motion → One coil excitation followed by Two coil excitation							
STEP	**B2 (Coil 4)**	**A2 (Coil 3)**	**B1 (Coil 2)**	**A1 (Coil 1)**	**Byte**	**Forward**	**Reverse**
1X	0	0	0	1	1	↓	↑
1Y	0	0	1	1	3		
2X	0	0	1	0	2		
2Y	0	1	1	0	6		
3X	0	1	0	0	4		
3Y	1	1	0	0	12		
4X	1	0	0	0	8		
4Y	1	0	0	1	9		

Hardware Interface

To run a stepper motor from a microprocessor trainer (microcomputer), we need a parallel port interface. Here we will be using Intel 8255 PPI (programmable peripheral interface) that has three 8-bit ports configurable in few modes. The 8255 has one control port where one can send the control word for configuring the 8255 ports (For details see 8255 data sheet). In this application, one port of 8255 should be configured as output port for stepper motor control signals to pass through. In MDA8086 trainer, the stepper motor interface is built in the motherboard. Upper 4-bits of Port B of the odd addressed 8255 are connected to the stepper motor circuitry. The signal mappings of the port lines are as follows:

Table 4 Stepper motor signals and power interface connector details

Port Bit	Phase
PB4	Coil A1
PB5	Coil B1
PB6	Coil A2
PB7	Coil B2

Experiments:

1. Rotate the motor continuously using one phase excitation mode (Half Step)
2. Rotate the motor continuously using two phase excitation mode (Half Step)
3. Rotate the motor continuously using both one and two phase excitation mode (Full Step)
4. Rotate the motor clockwise in 90º angle