SERVO MOTOR CONTROL USING 8051 MC

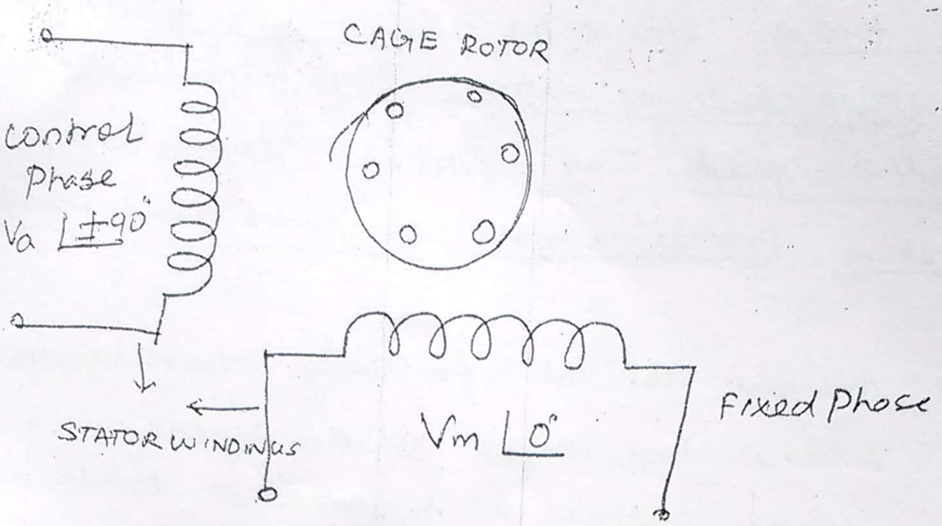
They are called control motors and have high torque. Due to the low inertia of the motor they have high speed of response. They generally operate at very low speeds. They find wide applications in radar, tracking, process control, computers and machine tools.

Servo motors has the following characteristics

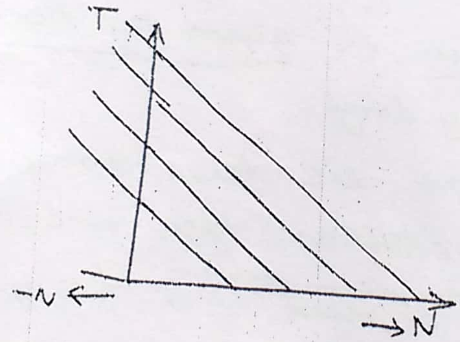
1. They produce high torque at all speeds.
2. They donot overheat at standstill or lower speeds
3. Due to lower inertia, they are able to reverse direction quickly
4. They are able to accelerate and decelerate quickly
5. They are able to return to given position time after time without any drift.

Most of the a.c servo motors are of two phase squirrel cage induction type and are used in low power applications. It runs at a frequency of 60HZ. The stator has two distributed windings which are displaced from each other by 90°. The main winding is called reference winding is supplied from a constant source $V_m \angle 0$. The other winding is supplied with a variable voltage of the same frequency as the reference phase but is displaced by 90°. The speed and torque of rotor are controlled by the phase difference between main and control windings. The phase voltage is

Using 8051 microcontroller. Reversing the phase difference reverses the motor direction



Since the rotor bars have high resistance, the torque speed characteristics for various armature voltages are almost linear over wide speed range.



The motor operation can be controlled by varying the main phase while keeping that of reference phase constant. The main phase is varied by a.c voltage regulator. The triggering PWM (pulse width modulation) pulses for the A.C. voltage controllers are provided by means of 8051 microcontrollers. The 8051 microcontroller generates the PWM pulses depending on the error in position

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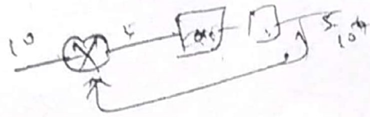

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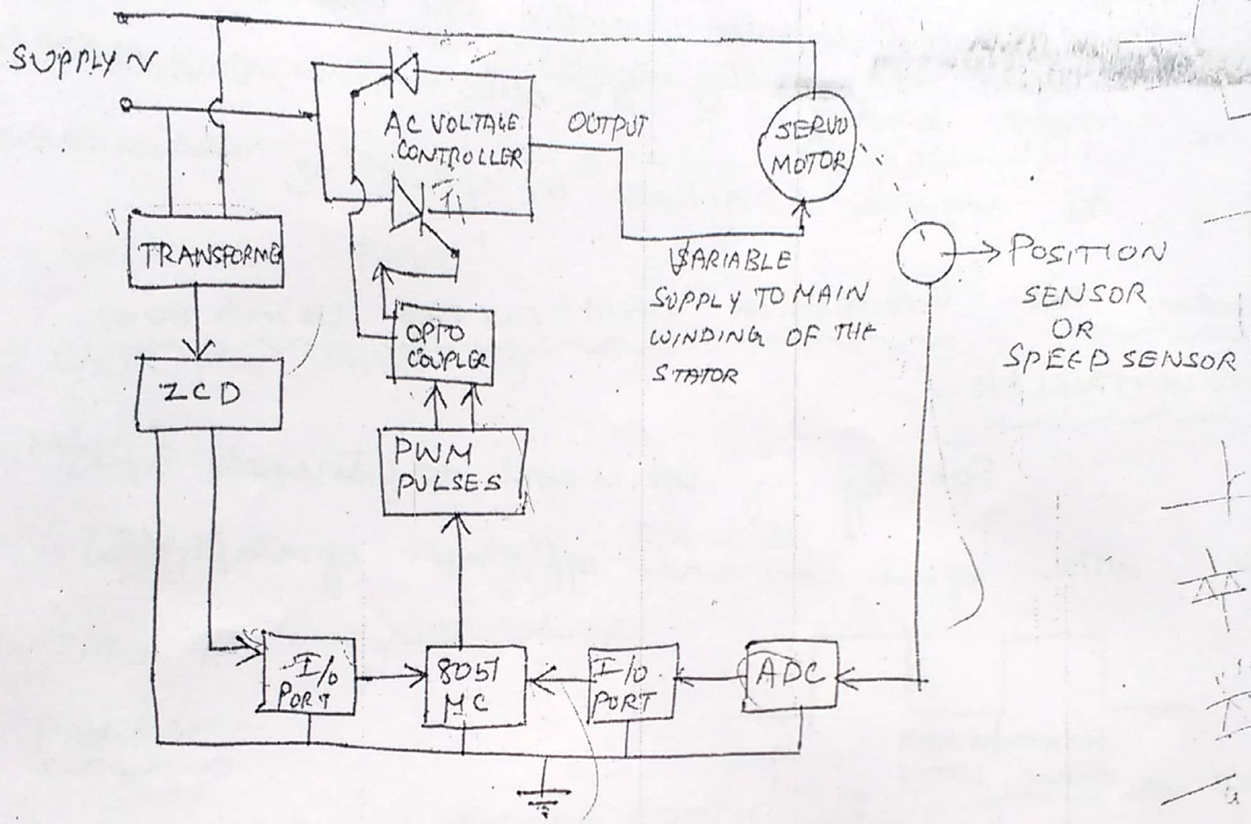
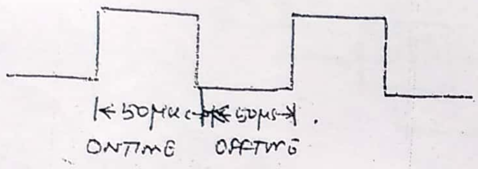
ANGULAR POSITION CONTROL / SPEED CONTROL OF SERVOMOTOR USING 8051 MICROCONTROLLER



A position sensor coupled to the a.c servo motor# gener a signal proportional to the instantaneous position. This analog signal is converted in to digital signal by Analog to digital converter. The ADC output is given through I/o port to the 8051 microcontroller. A step down transform has been provided to impress a scale down voltage in to ZCD (zero current detector) which converts the rectangula pulse and the microcontroller receives the signal through I/o port. Based on the two signals received, the microcon will provide a delayed PWM trigger pulses to the a.c volta controllers [to trigger the thyristors present in the a.c voltage controllers] The PWM pulses are given to the to the Gate of the thyristors through optocoupler. The function of the optocoupler is to isolate the control circuit from the power supply circuit. The output of the a.c voltage controller provides the variable voltage to the main winding (stator winding) of a.c servo motor, and thereby varying the angular position or speed of the servo motor.

PROGRAM FOR GENERATING PWM PULSES USING 8051 MICROCONTROLLER :-

For Eg if we want to generate a PWM pulses with equal ON and off time of 50 μ sec.



For Eg we are using Timer 0 in mode1, 1) First step is to calculate the count to be loaded in Timer register based on the PWM on & off period. For the above case

$$\text{count} = \frac{\text{Pulse period}}{\text{clock period}} = \frac{50\times10^{-6}}{1\times10^{-6}} = (50)_d = (32)_H$$

Count for 50μsec PWM period = FFFF − 32

= FFCD H

2) Load the count value in Timer registers, For the above case, TL0 is loaded with CD, TH0 is loaded with FF.

ALGORITHM:-

1. Load the TMOD register #01H to operate Timer0 in mode 1
2. Load the Timer0 registers, ie TH0, TL0 with FFH, CDH (count value for 50μsec PWM period)
3. Start the Timer
4. Check the Timer Flag
5. Clear TR0, TF0
6. Complement the port Pin 1.2
7. Stay at infinite loop.

PROGRAM:-

```
1.     MOV TMOD, #0000 0001H   ; To make the Timer0
                                 to operate in mode 1
loop2:- MOV TL0, #CDH          ; Load the Timer 0 registers
        MOV TH0, #FFH          TH0, TL0, with count value for
                               50μsec PWM period.
        SETB TR0               ; Start the Timer.
loop1:- JNB TF0, loop1         ; Check TF0.
        CLR TR0                ; Clear the Timer register
        CLR TF0                ; Clear the Timer Flag
        CPL P1.2               ; Complement the port Pin
                               2 of port 1 to get PWM pulses.
        SJMP loop2             ; Stay at infinite loop
```

Here the variable voltage to the main winding of the servo motor can be varied by varying the PWM period. Depending on the PWM period required, the count value is calculated and loaded in to the Timer 0 high and low registers (TL0, TH0). Varying the PWM period of the triggering pulses given to the a.c voltage regulator produces the variable voltage to the main winding of the stator which in turn varies the speed or angular position for the desired value.

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STEPPER MOTOR:- These motors are called stepping motors or step motors. This motor rotates through a fixed angular step in response to each input current pulse. The unique feature of stepper motor is that its output shaft rotates in a series of discrete angular intervals or steps, one step being taken each time a command pulse is received. When a definite no of pulses are supplied the shaft turns through a definite known angle.

Step angle:- The angle through which the motor shaft rotates for each command pulse (given by the microcontroller) is called the step angle. Greater the no of steps per revolution, higher the resolution, accuracy is also more. The common step angles are 1.8°, 2.5°, 7.5° and 15°. The values of step angle can be expressed either in terms of rotor & stator poles N_r, N_s.

$$\beta = \frac{N_s - N_r}{N_s \times N_r}$$

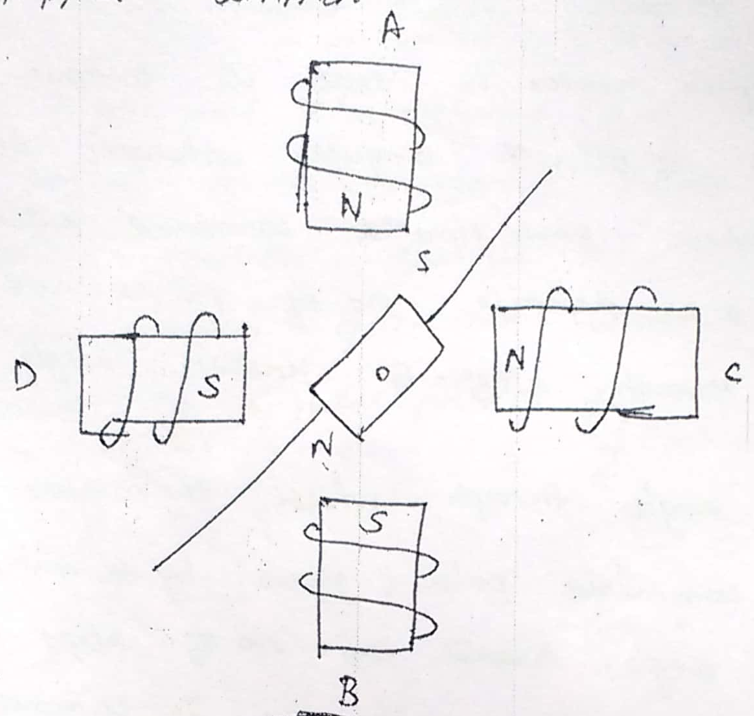
(or)

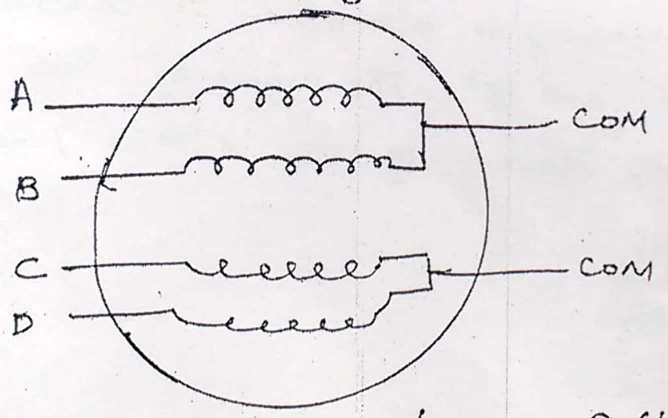
$$\beta = \frac{360^\circ}{mN_r},$$ step per second = $\frac{\text{RPM} \times \text{Steps per revolution}}{60}$

Resolution is given as No of steps / revolution $= 360°/\beta$

APPLICATIONS:- Stepper motor are used in control in computer peripheral (such as disk drives, dot matrix printers) textile industry, IC fabrications & robotics.

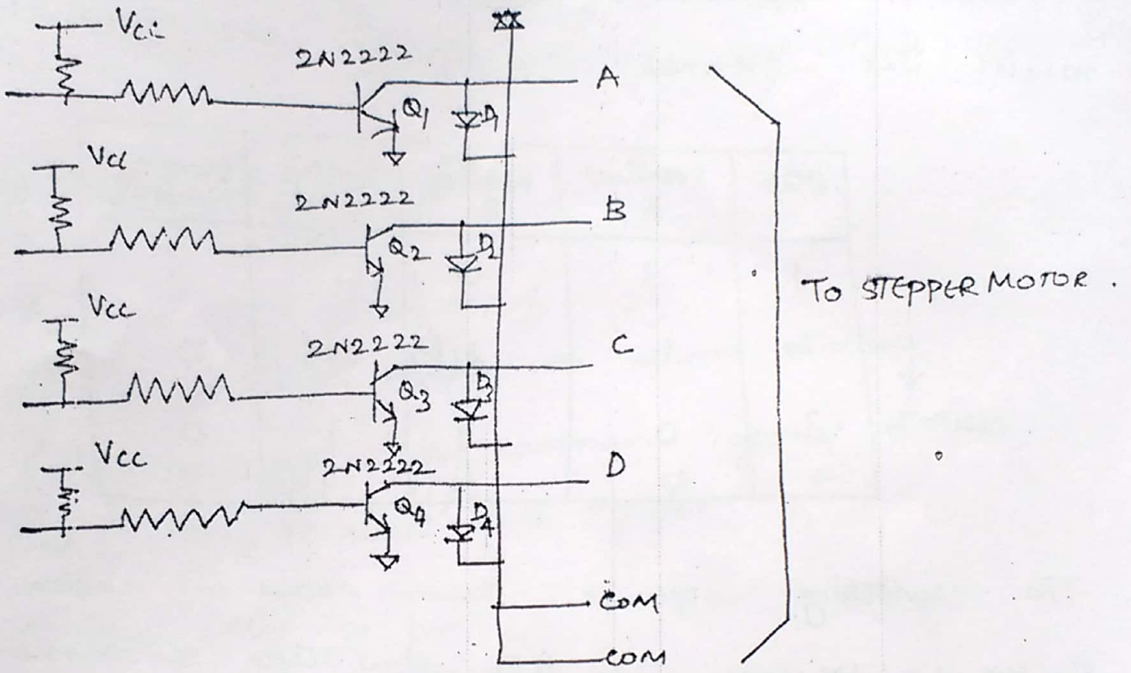
CONSTRUCTION:- Stepper motor has a permanent magn rotor (called shaft) surrounded by stator. The most stepper motor have four stator windings that are paired with centre tapped common





The center tap allows a change of current direction in each of two coils when winding is grounded, thereby resulting in polarity change of the stator The fixed movement is possible as a result of basic magnetic theory where poles of the same polarity repel and opposite poles attract The direction of rotation is dictated by stator poles. The

Here the common wires are connected to the positive side of the motor's power supply. Here +5V is sufficient. The four leads of the stator winding are controlled by four bits of the 8051 port i.e P1.0, P1.1, P1.2, P1.3
The driver such as ULN2003 to energize the stator windings
We can even use transistors as drivers instead of ULN 2003 as shown below



If transistors are used, diodes are also used to take care of the inductive current generated when the coil is turned off. But if ULN 2003 is used, it has internal diode to take care of back Emf.

ALGORITHM:-

1. Load the step sequence to Accumulator
2. Initialize ports (here port 1 alone)
3. More the step count for 4 step sequence from accumulator

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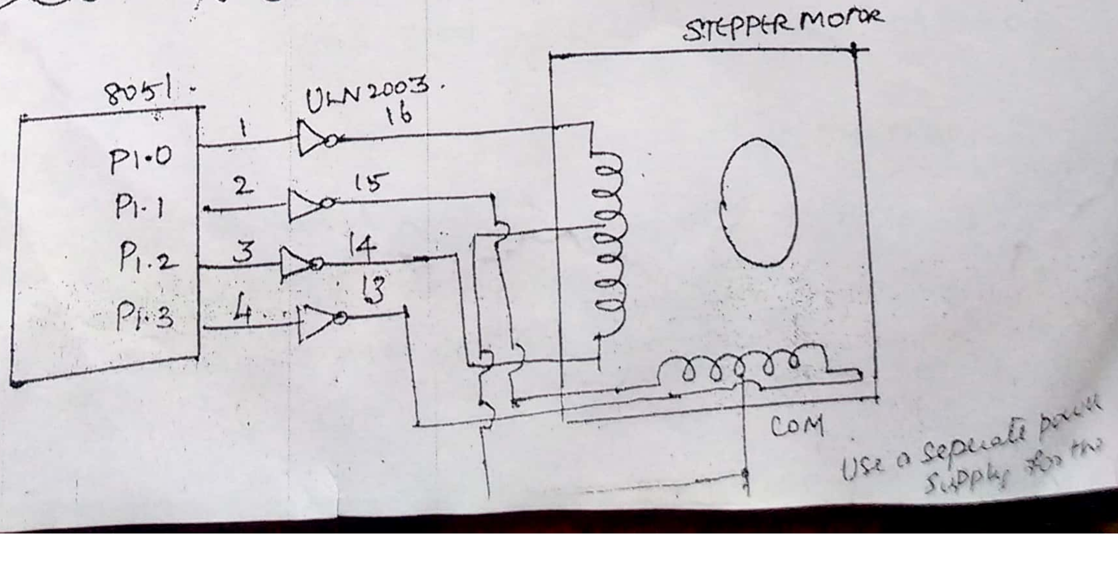
Stator poles are determined by the current sent through the wire coils. As the direction of current is changed, the polarity is also changed causing the reverse motion of the rotor. The stepper motor has four stator windings and 2 commons for the center tapped leads. As the sequence of power is applied to each stator winding, the rotor will rotate. The normal four sequence are shown below

Step	Winding A	Winding B	Winding C	Winding D	
1	1	0	0	1	09
2	1	~~1~~(0)	0(1)	0	0A
3	0	1	1	0	06
4	0	0(1)	1(0)	1	05
					09

clockwise ↓ counter clockwise ↑

The switching sequence shown above is called the 4 step switching sequence since after four steps the same two winding will be "ON".

STEPPER MOTOR CONTROL USING MICROCONTROLLER



to port

4. Rotate Right clockwise

5. call delay

Delay loop:-

66

0110 0110
→R

0011 0011
1001 1001

1. Load R2 with 100 (decimal)
2. Load R3 with 255 (decimal)
3. Decrement R3, if R3 ≠ 0 repeat step 3.
4. Decrement R2, if R2 ≠ 0 repeat step 2.
5. Return from interrupt

Program:-

```
      MOV   A, #66H       ; Load step sequence
BACK: MOV   P1, A         ; issue sequence to motor
      RR    A             ; rotate right clockwise
      ACALL Delay         ; wait
      SJMP  BACK          ; keep going
      . . . . .

DELAY
      MOV   R2 # 100      ; Load 100 in R2
H1:   MOV   R3 #255       ; Load 255 in R3.
H2:   DJNZ  R3, H2        ; Decrement R3 if R3 ≠ 0 repeat H2
      DJNZ  R2, H1        ; Decrement R2, if R2 ≠ 0 repeat H1
      RET
```