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Synchronisation, Speed and Direction Control of DC Motor

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Abstract

Industrial environment in day-to-day life demands for a synchronization between multiple devices present in the industry. So there should be a common synchronization between all these motors. Among the available motors even of single motors RPS is more the loss may be more. So keeping all these factors into consideration we designed a system, which is capable of driving multiple DC motors with the same speed, or RPS without any approximation. This system finds very useful in paper mills, steel industries etc. Motion control plays a vital role in industrial atomization. Different types of motors AC, DC, SERVO or stepper are used depending upon the application; of these DC motors are widely used because of easier controlling. Industrial applications use dc motors because the speed-torque relationship can be varied to almost any useful form for both dc motor and regeneration applications in either direction of rotation. DC motors feature a speed, which can be controlled smoothly down to zero, immediately followed by acceleration in the opposite direction without power circuit switching. Among the different control methods for DC motor armature voltage control method using pulse width modulation (PWM) is best one. Direction control can be achieved by the same microcontroller using slight modifications in its programming language. The combination provides smooth speed control in both clockwise as well as anticlockwise direction. Overall this project can provide higher efficiency and smooth operations control for any industrial plant.

1. INTRODUCTION

This paper provides a system that can utilized to use DC motor for various applications. We can utilize the DC Motor for various applications by controlling the speed and orientation according to the field of interest. Pulse Width Modulation (PWM) is the technique of utilizing switching devices to produce the effect of a continuously varying analog signal. To generate PWM signals we use AT89S52 microcontroller which is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The DC Motor used for the experiment is a 12V, 100 rpm DC Motor. One can use the same technique in larger motors also. Both push buttons as well as potentiometer can be used to vary the speed of the motors. Same change in speed will be reflected in both motors. Potentiometer control provides wide range of speed control while push buttons give more precise and accurate control but only over few selected speeds like 25, 50, 75 and 100 rpm. They can be set up manually according to use and can be changed later by editing in the microcontroller program. A 220/12V step down transformer is used to provide input to the DC motor whereas a regulator IC is used to provide 5V power supply to the microcontroller. Bridge rectifier is used in the circuit instead of centre tapped rectifier because of higher TUF and higher operating voltage for same PIV rating of both diodes. A smoothing capacitor acts as a Filter for conditioning the voltage waveform i.e. to convert pulsating DC into pure DC, however 100% pure DC is not obtained. The practical simulation of the circuit diagram is shown below.

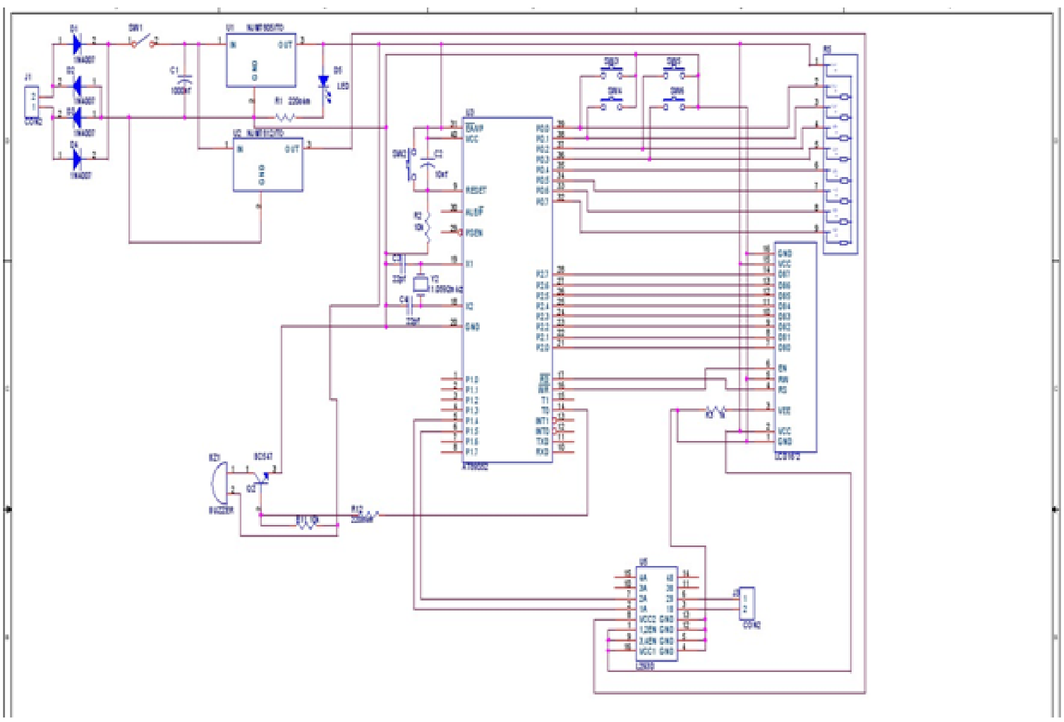

Fig 1: Simulation Diagram of Control Circuit

2. HARDWARE COMPONENTS

Following are the list of components used to make the control circuit along with their ratings which can vary according to the size of motor.

2.1 MICROCONTROLLER:

A microcontroller is a single chip that contains the processor (the CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes.

2.2 REGULATOR IC (78XX):

It is a three pin IC used as a voltage regulator. It converts unregulated DC current into regulated DC current. There are two types of voltage regulators 1. fixed voltage regulators (78xx, 79xx) 2. variable voltage regulators(LM317) In fixed voltage regulators there is another classification 1. +ve voltage regulators 2. -ve voltage regulators. Positive Voltage Regulators include 78xx voltage regulators. The most commonly used ones are 7805 and 7812. 7805 gives fixed 5V DC voltage if input voltage is in (7.5V, 20V).

2.3 POWER SUPPLY:

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. Here in our application we need a 5v DC power supply for all electronics involved in the project and 12V supply for the DC motors. This requires step down transformer, rectifier, voltage regulator, and filter circuit for generation of 5v DC power.

2.4 BRIDGE RECTIFIER:

A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification. This is a widely used configuration, both with individual diodes wired as shown and with single component bridges where the diode bridge is wired internally.

2.5 SMOOTHENING CAPACITOR:

The function of this capacitor is to lessen the variation in the rectified AC output voltage waveform from the bridge. One explanation of 'smoothing' is that the capacitor provides a low impedance path to the AC component of the output, reducing the AC voltage across, and AC current through, the resistive load. In less technical terms, any drop in the output voltage and current of the bridge tends to be canceled by loss of charge in the capacitor. This charge flows out as additional current through the load. Thus the change of load current and voltage is reduced relative to what would occur without the capacitor. Increases of voltage correspondingly store excess charge in the capacitor, thus moderating the change in output voltage / current.

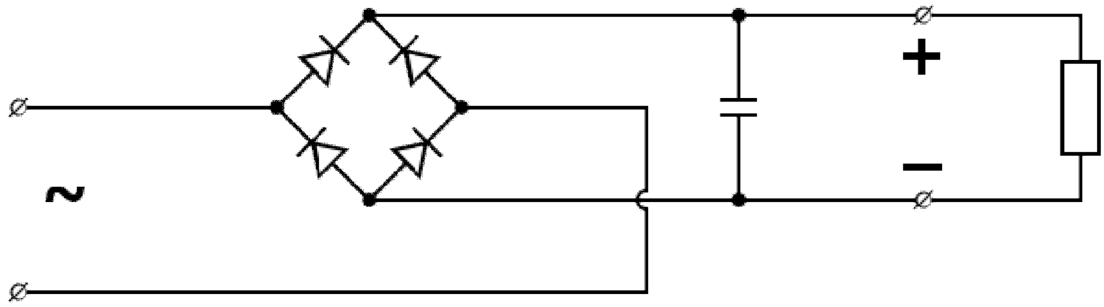

Fig 2: Output Smoothing Circuit

2.6 DC MOTOR:

DC Motor has two leads. It has bidirectional motion

2.6.1 If we apply +ve to one lead and ground to another motor will rotate in one direction, if we reverse the connection the motor will rotate in opposite direction.

2.6.2 If we keep both leads open or both leads ground it will not rotate (but some inertia will be there).

2.6.3 If we apply +ve voltage to both leads then braking will occurs.

2.7 H BRIDGE:

This circuit is known as H-Bridge because it looks like "H".

2.7.1 If switch (A1 and A2) are on, switch (B1 and B2) are off then motor rotates in clkwise direction.

2.7.2 If switch (**B**1 and B2) are on, switch (A1 and A2) are off then motor rotates in Anti clk direction.

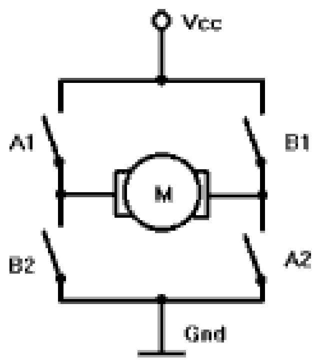

Fig 3: H Bridge

3. PULSE WIDHT MODULATION CONTROL

Pulse width modulation is about the switching speed and pulse width (duty cycle).

The duty cycle is defined as percentage of digital ‘high’ to digital ‘low’ plus digital ‘high’ pulse width during a PWM period, i.e, the duty cycle is the ratio of signal Ton/T, where T is the period of signal.

The PWM signals are produced by the microcontroller itself. An advantage of using the microcontroller to generate the PWM signal for us is that once it has been set up correctly the PWM signal will continue to be generated automatically in the background. There is no need to write any complicated interrupt routine or other timing code. The good thing is that by simply changing the comparator value, the duty cycle of the PWM can alter. All of the PWM facilities are provided by the internal Timers of the microcontroller.

The average of voltage that supply to DC motor is given by,

$V_{ave}= (t_{on}/T) * V_{in}$ [2.5] ; Where, V_{ave} = average voltage supply to DC motor

t_{on} = time ON of switches , T = period of PWM

(T_{on}/T) = DC, duty cycle

4. SCHEMATIC OF L293D WITH DC MOTOR

4.1 *μ VISION*:

The μ Vision IDE is, for most developers, the easiest way to create embedded system programs.

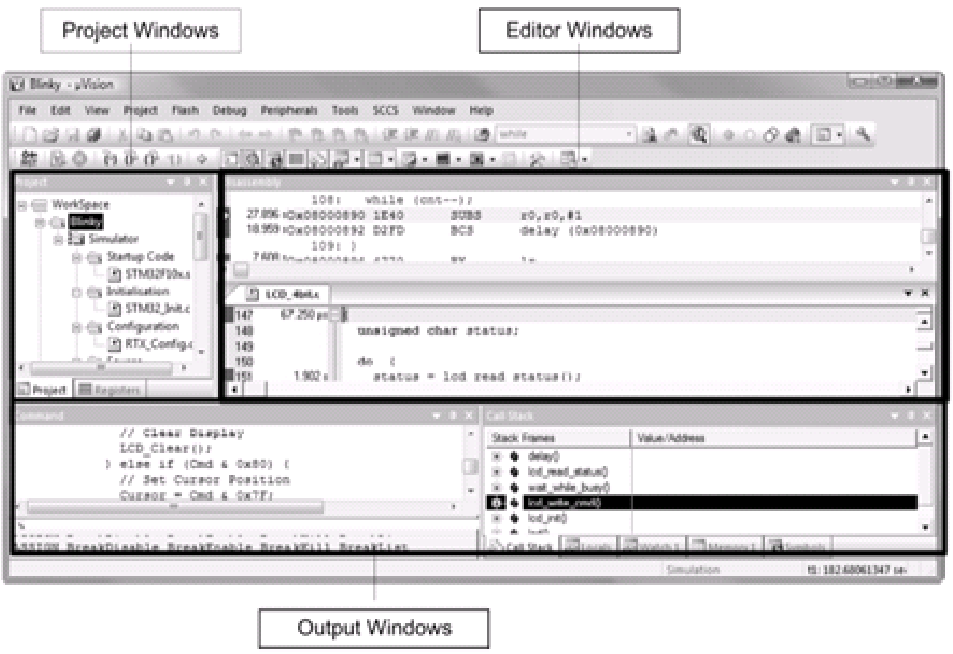

Fig 4: μVISION Screen

μ Vision windows can be re-arranged, tiled, and attached to other screen areas or windows respectively It is possible to drag and drop windows, objects, and variables.

The **Project Windows** area is that part of the screen in which, by default, the Project Window, Functions Window, Books Window, and Registers Window are displayed. Within the **Editor Windows** area, you are able to change the source code, view performance and analysis information, and check the disassembly code. The **Output Windows** area provides information related to debugging, memory, symbols, call stack, local variables, commands, browse information, and find in files results. If, for any reason, you do not see a particular window and have tried displaying/hiding it several times, please invoke the default layout of µVision through the **Window – Reset Current Layout** Menu**.**

4.2 8051 Burner Software:

PRO51 BURNER provides you with software burning tools for 8051 based Microcontrollers in there Flash memory. The 51 BURNER tools, you can burn AT89SXXXX series of ATMEL microcontrollers.

5. MICROCONTROLLER PROGRAMMING

```
#include<reg52.h>
#define LCD_PORT P2
sbit RS=P3^7;
sbit EN=P3^6;
sbit sw1=P3^5;
sbit sw2=P3^4;
sbit sw3=P3^3;
sbit sw4=P3^2;
sbit sw5=P3^1;
sbit sw6=P3^0;
sbit M1 = P1^0;
sbit M2 = P1^1;
sbit M3 = P1^2;
sbit M4 = P1^3;
unsigned char pwm_width;
unsigned char pwm_high_width;
unsigned char pwm_low_width;
bit pwm_flag = 0;
unsigned char i=0;
void timer0() interrupt 1
{ if(!pwm_flag)
{pwm_flag = 1;//Set flag
if(i==0)
{M1 = 1;                    //Set PWM o/p pin
M3 = 1;}
if(i==1)
{M2 = 1;                  //Set PWM o/p pin
M4 = 1;}
```

```
TH0 = pwm_high_width;       //Load timer
TF0 = 0;                    //Clear interrupt flag
return; }                   //Return
else
{pwm_flag = 0;                        //Clear flag
if(i==0)
{M1 = 0;                    //Set PWM o/p pin
M3 = 0;}
if(i==1)
{M2 = 0;                    //Set PWM o/p pin
M4 = 0;}
TH0 = 255- pwm_low_width;                       //Load timer
TF0 = 0;                              //Clear Interrupt flag
return; }}                            //return
void lcdinit(void);
void lcdData(unsigned char l);
void lcdcmd(unsigned char k);
void DelayMs(unsigned int count);
void lcd_puts(unsigned char *ch);
void main()
{TMOD=0x20;
sw1=1;
sw2=1;
sw3=1;
sw4=1;
sw5=1;
sw6=1;
M1=0;
M2=0;
M3=0;
M4=0;
lcdinit();
lcd_puts("DC MOTOR SPEED  CONTROL  ");
while(1)
{if(sw1==0)
{EA = 0;
ET0 = 0;
TR0 = 0;
M1=1;
M2=0;
M3=1;
M4=0;
i=0;
lcdcmd(0x80);
lcd_puts("CLOCKWISE       ");
```

```
lcdcmd(0xC0);
lcd_puts("FULL SPEED      ");}
if(sw2==0)
{EA = 0;
ET0 = 0;
TR0 = 0;
M1=0;
M2=1;
M3=0;
M4=1;
i=1;
lcdcmd(0x80);
lcd_puts("ANTICLOCKWISE   ");
lcdcmd(0x00);
lcd_puts("FULL SPEED      ");}
if(sw3==0)
{TMOD = 0x00;
EA = 1;
ET0 = 1;
pwm_width=20;
pwm_high_width=pwm_width;
pwm_low_width=5*pwm_width;
lcdcmd(0x00);
lcd_puts("SPEED 1        ");}
if(sw4==0)
{EA = 1;
ET0 = 1;
pwm_width=30;
pwm_high_width=pwm_width;
pwm_low_width=5*pwm_width;
lcdcmd(0x80);
lcd_puts("SPEED 2        ");}
if(sw5==0)
{EA = 1;
ET0 = 1;
pwm_width=40;
pwm_high_width=pwm_width;
pwm_low_width=5*pwm_width;
lcdcmd(0x80);
lcd_puts("SPEED 3        ");}
if(sw6==0)
{M1=0;
M2=0;
M3=0;
M4=0;
```

```
EA = 0;
ET0 = 0;
lcdcmd(0x80);
lcd_puts("STOP          ");     }}}
void lcdinit(void)
{lcdcmd(0x38);
DelayMs(50);
lcdcmd(0x0C);
DelayMs(50);
lcdcmd(0x01);
DelayMs(50);
lcdcmd(0x06);
DelayMs(50);
lcdcmd(0x80);
DelayMs(50);}
void lcdData(unsigned char l)
{LCD_PORT=l;
RS=1;
EN=1;
DelayMs(1);
EN=0;
return;}
void lcdcmd(unsigned char k)
{LCD_PORT=k;
RS=0;
EN=1;
DelayMs(1);
EN=0;
return;}
void DelayMs(unsigned int count)
{unsigned int i;
 while(count)
{i = 115;
while(i>0) i--;
count--;    }}
void lcd_puts(unsigned char *ch)
{unsigned char i=0;
while(ch[i]!='\0')
{lcdData(ch[i]);
i++;
if(i==16)
lcdcmd(0xC0);          }}
```

6. CONCLUSION

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are a means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motors are used to power hundreds of devices we use in everyday life. With this very basic concept of direction and speed control we can move the motor clockwise and anticlockwise as a result lift can move in forward and backward direction and we can vary the speed of a dc motor. The function that each drive performs is readily programmable. The drives are forced into coordination and synchronization by some sort of software mechanism which is also implemented by programming. The speed synchronization is provided with the help of the PMW technique on the LCD. DC motors are ideally suited to a multitude of industrial and marine applications in which high torque and variable speed are required. These applications include ship propulsion, mine hoists and steel rolling mills. They also drive many other types of industrial equipment such as fan drives, Banbury mixers and extruders.

7. REFERENCE

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