Chapter Six
Conclusion and recommendations

6.1 Conclusion:

The objective of this work is to develop a control system drive for the assistive limb by considering modification of existing control theory. The driving circuit for the supervisory control of four DC motors to helps to oscillate hand flexion and extension. The microcontroller used is ATmega16 to control the DC series motors for the desired position. Prosthetic arm is a boon for those persons who have lost their arm due to some mishap. One of the main requirements of artificial arm are it's functionally. It should be near to natural hand as possible. In the present study a prototype of prosthetic arm has been developed for two movements – arm up/down movement and arm clockwise/anticlockwise movement.

6.2 recommendations:

- More arm functions can be added to improve DOF.
- Trying to complete assembly of the full hand with fingers.

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Appendix (A): Program code

```
$regfile = "m16def.dat"                    ' specify the used micro

$crystal = 8000000                         ' used crystal frequency

Config Lcd = 40 * 2                        'configure lcd screen

Config Lcd pin = Pin , Db4 = Portc.4 , Db5 = Portc.5 , Db6 = Portc.6 ,
Db7 = Portc.7 , E = Portc.3 , Rs = Portc.  'These settings are for the
STK200 in PIN mode

Config Portd = Output

Config Adc = Single , Prescaler = Auto , Reference = Avcc   'Now give
power to the chip

Start Adc                  ' NOT required since it will start automatic

Dim A As Integer

Dim B As Integer

Dim C As Integer

Dim D As Integer

Dim E As Integer

Dim F As Integer

Dim G As Integer

Dim H As Integer

Dim W As Integer

Dim X As Integer
```

```
Dim Y As Integer

Dim Z As Integer

Lcd "WELLCOME"

Waitms 1000

Cls

Waitms 1000

Lcd "sudan university of science & technology"

Waitms 1000

Cls

Lcd "Prosthetic Arm Control Using Microcontroller"

Waitms 1000

Cls

Do

A = Getadc(0)

B = Getadc(1)

C = Getadc(2)

D = Getadc(3)

E = A + 2

F = B + 2
```

```
H = C + 2

G = D + 2

W = E / 205

X = F / 205

Y = H / 205

Z = G / 205

Lcd "W="

Lcd W

Waitms 1000

If W > 0 And W <= 2 Then                    'down Elbow

Portd.0 = 0

Portd.1 = 1

Waitms 1000

Portd.0 = 0

Portd.1 = 0

Waitms 1000

End If

If W <= 5 And W > 2 Then                    'Up Elbow

Portd.0 = 1
```

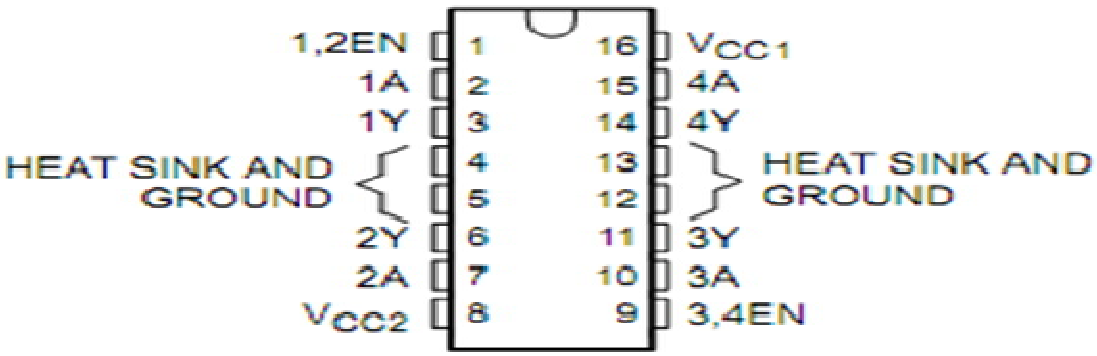
```
Portd.1 = 0

Waitms 1000

Portd.0 = 0

Portd.1 = 0

End If

Lcd "    X="

Lcd X

Waitms 1000

If X > 0 And X <= 2 Then                    'Clockwise Elbow

Portd.2 = 0

Portd.3 = 1

Waitms 1000

Portd.2 = 0

Portd.3 = 0

Waitms 1000

End If

If X <= 5 And X > 2 Then                    'Anticlockwise Elbow

Portd.2 = 1

Portd.3 = 0
```

```
Waitms 1000
Portd.2 = 0
Portd.3 = 0
End If
Lcd "    Y="
Lcd Y
Waitms 1000
If Y > 0 And Y <= 2 Then                    'Down Hand
Portd.4 = 0
Portd.5 = 1
Waitms 1000
Portd.4 = 0
Portd.5 = 0
Waitms 1000
End If
If Y <= 5 And Y > 2 Then                    'Up hand
Portd.4 = 1
Portd.5 = 0
Waitms 1000
```

```
Portd.4 = 0

Portd.5 = 0

End If

Lcd "   Z="

Lcd Z

Waitms 1000

If Z > 0 And Z <= 2 Then                    'Clockwise Hand

Portd.6 = 0

Portd.7 = 1

Waitms 1000

Portd.6 = 0

Portd.7 = 0

Waitms 1000

End If

If Z <= 5 And Z > 2 Then                    'Anticlockwise Hand

Portd.6 = 1

Portd.7 = 0

Waitms 1000

Portd.6 = 0
```

```
Portd.7 = 0

End If

End

Loop

End
```

Appendix (B): Data sheet of L293D

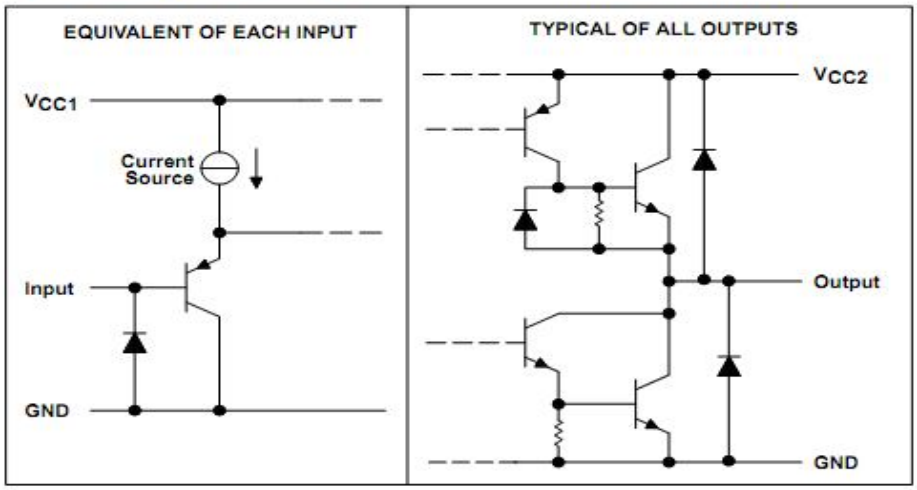


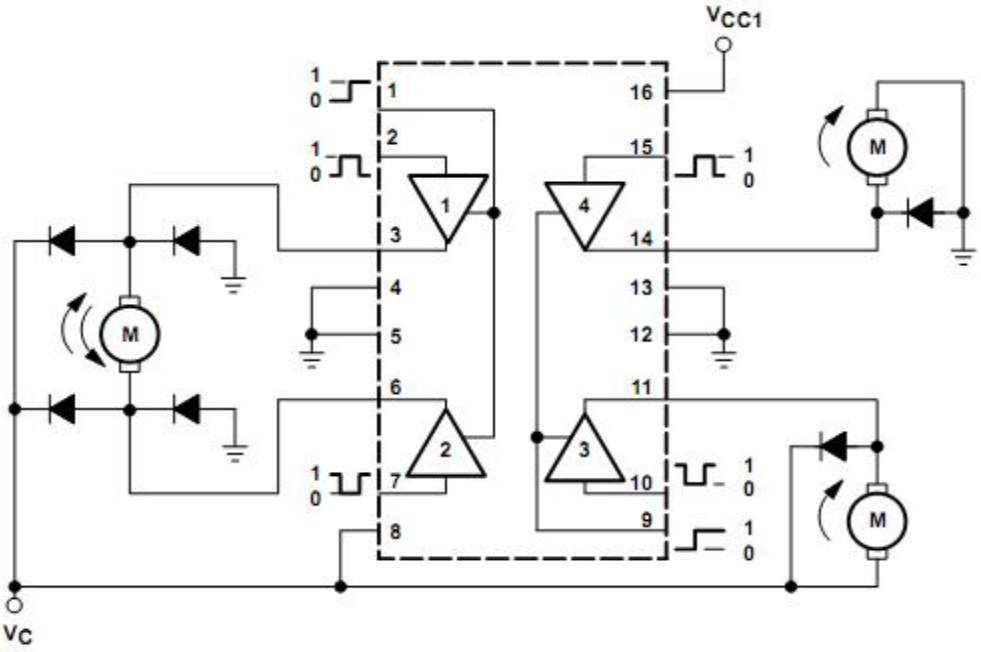
Description of L293D:

The L293D is quadruple high-current half-H drivers. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. The device is designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

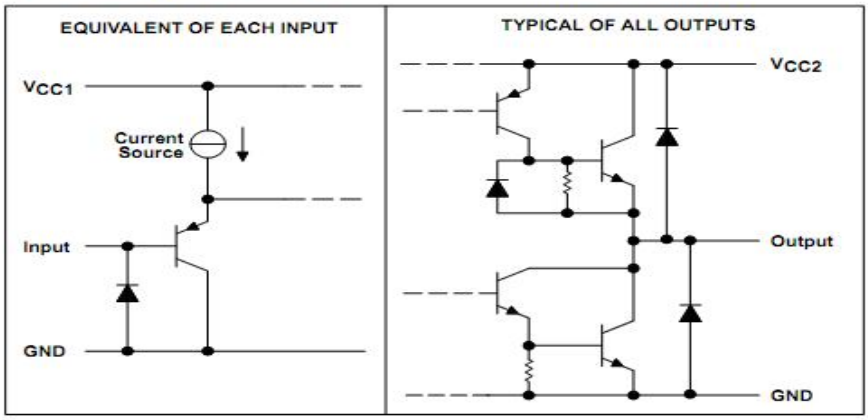
All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. The L293D is characterized for operation from 0°C to 70°C.

schematics of inputs and outputs (L293D)





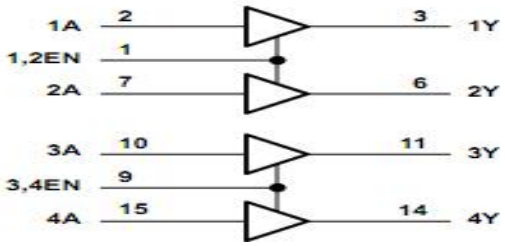
schematics of inputs and outputs (L293D)



FUNCTION TABLE
(each driver)

INPUTS†		OUTPUT
A	EN	Y
H	H	H
L	H	L
X	L	Z

H = high level, L = low level, X = irrelevant,
Z = high impedance (off)
† In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC1} (see Note 1) . . . . . 36 V
Output supply voltage, V_{CC2} . . . . . 36 V
Input voltage, V_I . . . . . 7 V
Output voltage range, V_O . . . . . –3 V to V_{CC2} + 3 V
Peak output current, I_O (nonrepetitive, t ≤ 5 ms): L293 . . . . . ±2 A
Peak output current, I_O (nonrepetitive, t ≤ 100 µs): L293D . . . . . ±1.2 A
Continuous output current, I_O: L293 . . . . . ±1 A
Continuous output current, I_O: L293D . . . . . ±600 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Notes 2 and 3) . . . . . 2075 mW
Continuous total dissipation at 80°C case temperature (see Note 3) . . . . . 5000 mW
Maximum junction temperature, T_J . . . . . 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C

recommended operating conditions

			MIN	MAX	UNIT
	Supply voltage	V_{CC1}	4.5	7	V
		V_{CC2}	V_{CC1}	36	
V_{IH}	High-level input voltage	$V_{CC1} \le 7$ V	2.3	V_{CC1}	V
		$V_{CC1} \ge 7$ V	2.3	7	V
V_{IL}	Low-level output voltage		–0.3†	1.5	V
T_A	Operating free-air temperature		0	70	°C

† The algebraic convention, in which the least positive (most negative) designated minimum, is used in this data sheet for logic voltage levels.

electrical characteristics, V_{CC1} = 5 V, V_{CC2} = 24 V, T_A = 25°C

PARAMETER			TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage		L293: I_{OH} = –1 A L293D: I_{OH} = –0.6 A		V_{CC2}–1.8	V_{CC2}–1.4		V
V_{OL}	Low-level output voltage		L293: I_{OL} = 1 A L293D: I_{OL} = 0.6 A			1.2	1.8	V
V_{OKH}	High-level output clamp voltage		L293D: I_{OK} = –0.6 A			V_{CC2} + 1.3		V
V_{OKL}	Low-level output clamp voltage		L293D: I_{OK} = 0.6 A			1.3		V
I_{IH}	High-level input current	A	V_I = 7 V			0.2	100	µA
		EN				0.2	10	
I_{IL}	Low-level input current	A	V_I = 0			–3	–10	µA
		EN				–2	–100	
I_{CC1}	Logic supply current		I_O = 0	All outputs at high level		13	22	mA
				All outputs at low level		35	60	
				All outputs at high impedance		8	24	
I_{CC2}	Output supply current		I_O = 0	All outputs at high level		14	24	mA
				All outputs at low level		2	6	
				All outputs at high impedance		2	4	

switching characteristics, V_{CC1} = 5 V, V_{CC2} = 24 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	L293NE, L293DNE			UNIT
			MIN	TYP	MAX	
t_{PLH}	Propagation delay time, low-to-high-level output from A input	C_L = 30 pF, See Figure 1		800		ns
t_{PHL}	Propagation delay time, high-to-low-level output from A input			400		ns
t_{TLH}	Transition time, low-to-high-level output			300		ns
t_{THL}	Transition time, high-to-low-level output			300		ns

switching characteristics, V_{CC1} = 5 V, V_{CC2} = 24 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	L293DWP, L293N L293DDWP, L293DN			UNIT
			MIN	TYP	MAX	
t_{PLH}	Propagation delay time, low-to-high-level output from A input	C_L = 30 pF, See Figure 1		750		ns
t_{PHL}	Propagation delay time, high-to-low-level output from A input			200		ns
t_{TLH}	Transition time, low-to-high-level output			100		ns
t_{THL}	Transition time, high-to-low-level output			350		ns