DC Motor with Joystick Controller Using Arduino Uno

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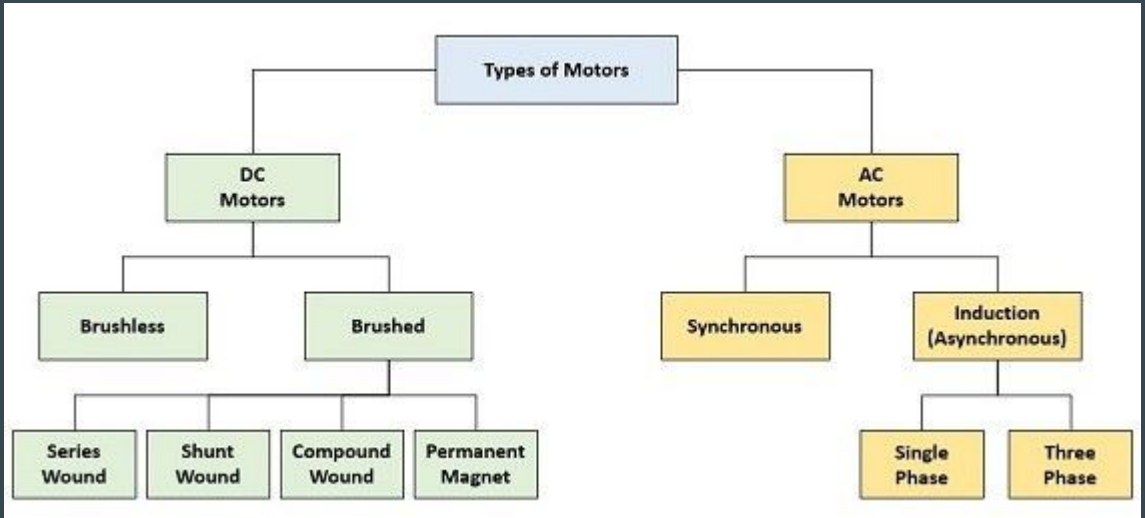
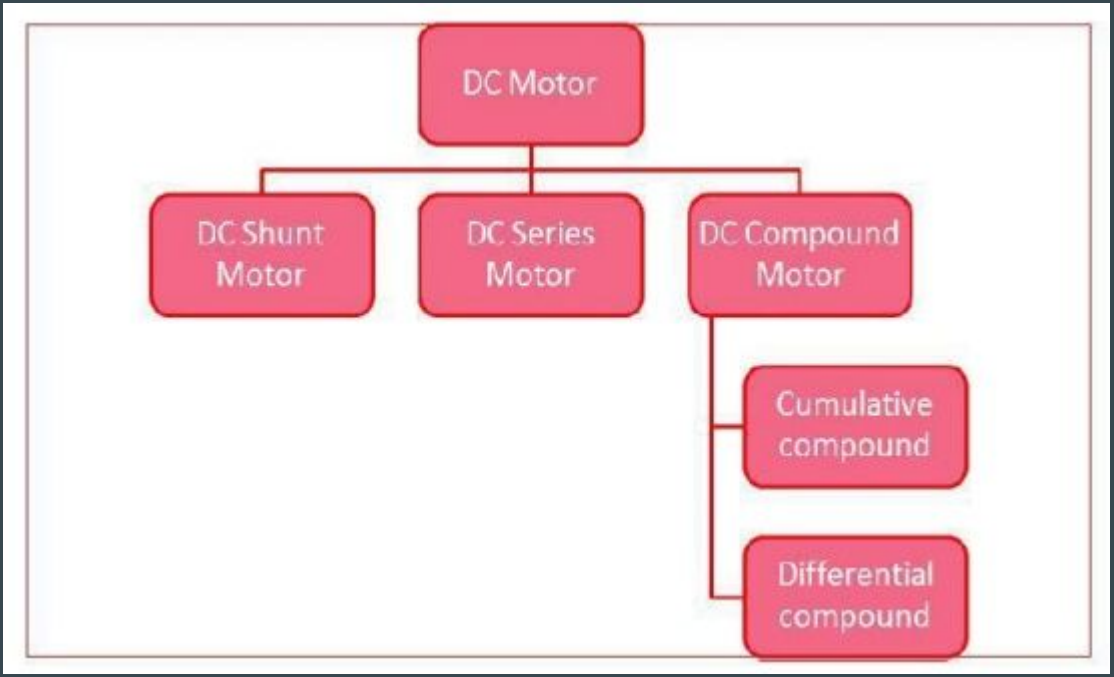
Introduction

- The objective of this project is to build a DC motor that can be controlled by a joystick.
- We will be using Arduino Uno board to dictate the direction the DC motor will be rotating in either clockwise or counterclockwise direction.
- We will be uploading C++ code from the Arduino IDE to the Uno board so it can send signals triggered by the joystick to the DC motor

Types of Motors



Types of DC Motors



Application of DC Motor

DC motors are suitable for many applications such as Cars, Elevators, Air compressors, Vacuums and others.

They are

- adjustable speed and where constant or low-speed torque are required
- work well in dynamic braking and reversing applications
- quick acceleration, stopping and reversing – along with their linear-speed torque curve

Why DC Motor is the most suitable motor?

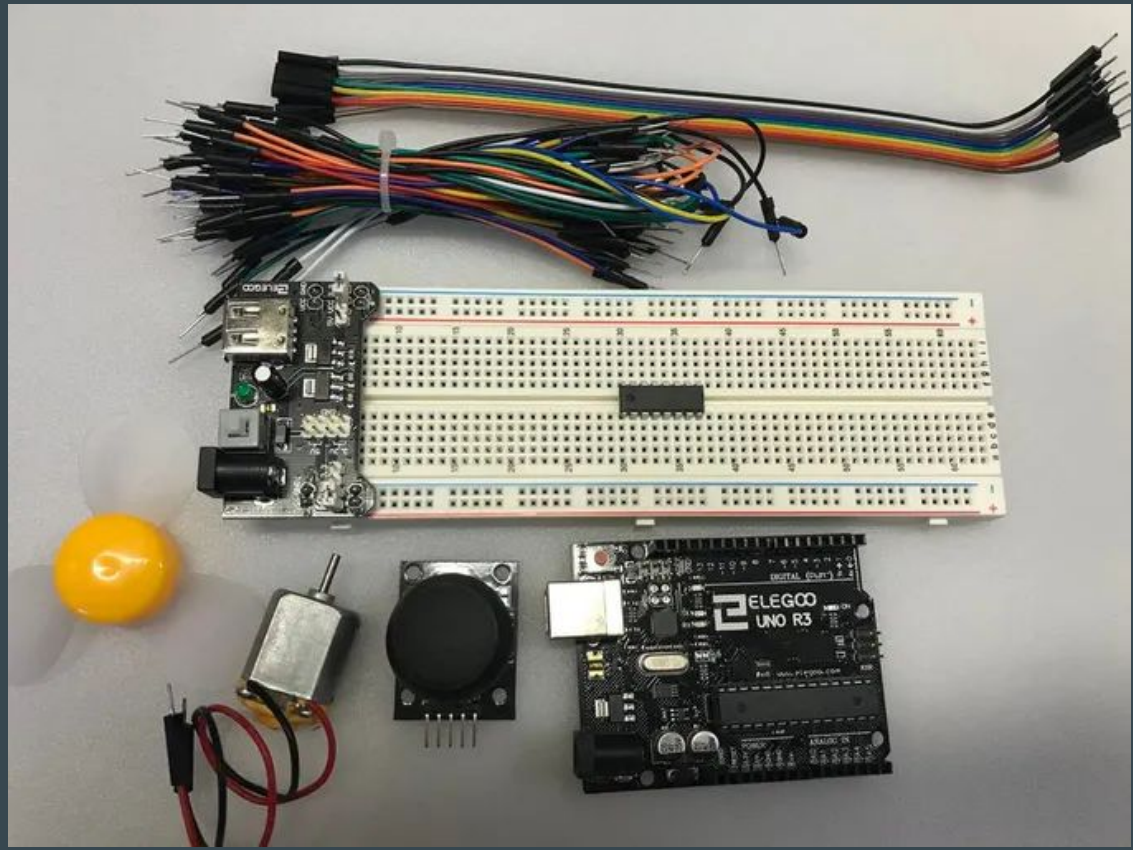
DC motors are often selected instead of AC motors for many reasons

- low-cost option
- Installations plus repairing a DC motor with a new one easier
- Easy to vary Motor Speed.
- Full torque at speed zero.
- Higher Power density compared AC motor
- are smaller and compact size

Parts List

Elegoo Uno R3 Super Starter kit

- Arduino Uno R3 board
- L293D Motor Driver IC
- DC Motor
- Joystick Module
- Breadboard with DC power supply
- Jumper Wires
- Fan
- Power Supply Module

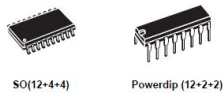


Motor Driver Datasheet for L293 IC

L293D
L293DD

PUSH-PULL FOUR CHANNEL DRIVER WITH DIODES

- 600mA OUTPUT CURRENT CAPABILITY PER CHANNEL
- 1.2A PEAK OUTPUT CURRENT (non repetitive) PER CHANNEL
- ENABLE FACILITY
- OVERTEMPERATURE PROTECTION
- LOGICAL "0" INPUT VOLTAGE UP TO 1.5 V (HIGH NOISE IMMUNITY)
- INTERNAL CLAMP DIODES



SO(12+4+4) Powerdip (12+2+2)

ORDERING NUMBERS:

L293DD L293D

DESCRIPTION

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoides, DC and stepping motors) and switching power transistors.

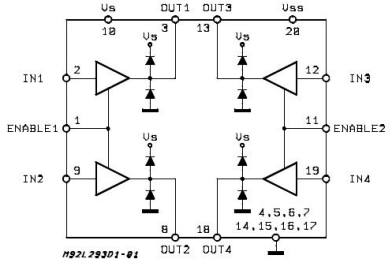
To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included.

This device is suitable for use in switching applications at frequencies up to 5 kHz.

The L293D is assembled in a 16 lead plastic packaage which has 4 center pins connected together and used for heatsinking

The L293DD is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heatsinking.

BLOCK DIAGRAM

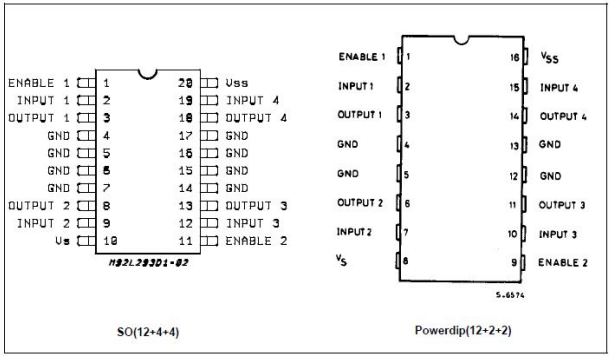


L293D - L293DD

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	36	V
V_{SS}	Logic Supply Voltage	36	V
V_i	Input Voltage	7	V
V_{en}	Enable Voltage	7	V
I_o	Peak Output Current (100 µs non repetitive)	1.2	A
P_{tot}	Total Power Dissipation at T_{pins} = 90 °C	4	W
T_{stg}, T_j	Storage and Junction Temperature	– 40 to 150	°C

PIN CONNECTIONS (Top view)



THERMAL DATA

Symbol	Decription		DIP	SO	Unit
$R_{th\ j\text{-}pins}$	Thermal Resistance Junction-pins	max.	–	14	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance junction-ambient	max.	80	50 (*)	°C/W
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	max.	14	–	

(*) With 6sq. cm on board heatsink.

ELECTRICAL CHARACTERISTICS (for each channel, V_S = 24 V, V_{SS} = 5 V, T_{amb} = 25 °C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_S	Supply Voltage (pin 10)		V_{SS}		36	V
V_{SS}	Logic Supply Voltage (pin 20)		4.5		36	V
I_S	Total Quiescent Supply Current (pin 10)	V_i = L ; I_O = 0 ; V_{en} = H		2	6	mA
		V_i = H ; I_O = 0 ; V_{en} = H		16	24	mA
		V_{en} = L			4	mA
I_{SS}	Total Quiescent Logic Supply Current (pin 20)	V_i = L ; I_O = 0 ; V_{en} = H		44	60	mA
		V_i = H ; I_O = 0 ; V_{en} = H		16	22	mA
		V_{en} = L		16	24	mA
V_{IL}	Input Low Voltage (pin 2, 9, 12, 19)		– 0.3		1.5	V
V_{IH}	Input High Voltage (pin 2, 9, 12, 19)	$V_{SS} \leq 7$ V	2.3		V_{SS}	V
		$V_{SS} > 7$ V	2.3		7	V
I_{IL}	Low Voltage Input Current (pin 2, 9, 12, 19)	V_{IL} = 1.5 V			– 10	µA
I_{IH}	High Voltage Input Current (pin 2, 9, 12, 19)	2.3 V ≤ V_{IH} ≤ V_{SS} – 0.6 V		30	100	µA
$V_{en\ L}$	Enable Low Voltage (pin 1, 11)		– 0.3		1.5	V
$V_{en\ H}$	Enable High Voltage (pin 1, 11)	$V_{SS} \leq 7$ V	2.3		V_{SS}	V
		$V_{SS} > 7$ V	2.3		7	V
$I_{en\ L}$	Low Voltage Enable Current (pin 1, 11)	$V_{en\ L}$ = 1.5 V		– 30	– 100	µA
$I_{en\ H}$	High Voltage Enable Current (pin 1, 11)	2.3 V ≤ $V_{en\ H}$ ≤ V_{SS} – 0.6 V			± 10	µA
$V_{CE(sat)H}$	Source Output Saturation Voltage (pins 3, 8, 13, 18)	I_O = – 0.6 A		1.4	1.8	V
$V_{CE(sat)L}$	Sink Output Saturation Voltage (pins 3, 8, 13, 18)	I_O = + 0.6 A		1.2	1.8	V
V_F	Clamp Diode Forward Voltage	I_O = 600nA		1.3		V
t_r	Rise Time (*)	0.1 to 0.9 V_O		250		ns
t_f	Fall Time (*)	0.9 to 0.1 V_O		250		ns
t_{on}	Turn-on Delay (*)	0.5 V_i to 0.5 V_O		750		ns
t_{off}	Turn-off Delay (*)	0.5 V_i to 0.5 V_O		200		ns

(*) See fig. 1.

Motor Driver Datasheet for L293 IC (Cont.)

TRUTH TABLE (one channel)

Input	Enable (*)	Output
H	H	H
L	H	L
H	L	Z
L	L	Z

Z = High output impedance
(*) Relative to the considered channel

Figure 1: Switching Times

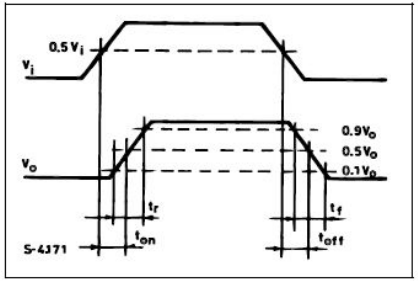
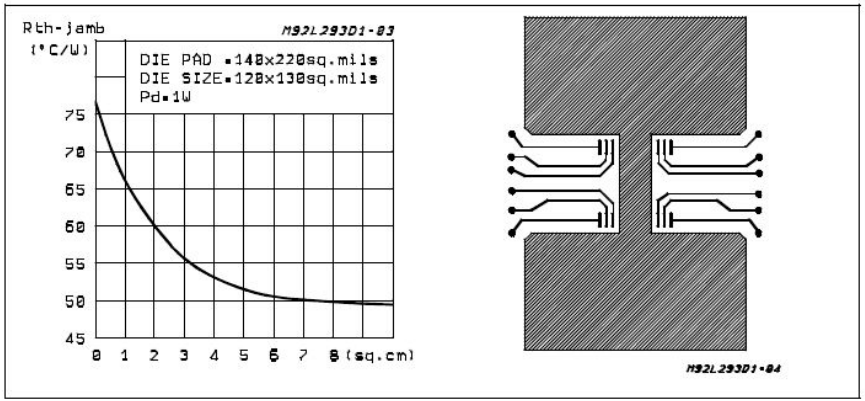
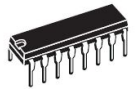


Figure 2: Junction to ambient thermal resistance vs. area on board heatsink (SO12+4+4 package)

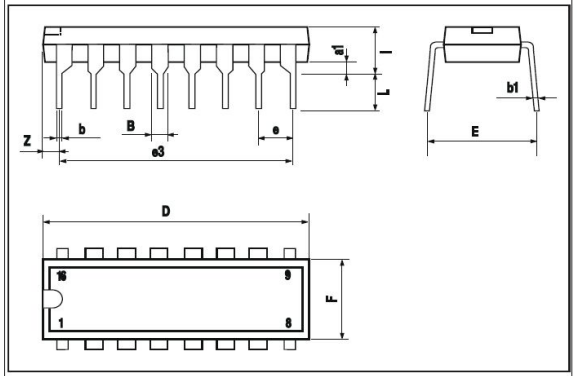


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.85		1.40	0.033		0.055
b		0.50			0.020	
b1	0.38		0.50	0.015		0.020
D			20.0			0.787
E		8.80			0.346	
e		2.54			0.100	
e3		17.78			0.700	
F			7.10			0.280
I			5.10			0.201
L		3.30			0.130	
Z			1.27			0.050

OUTLINE AND MECHANICAL DATA



Powerdip 16

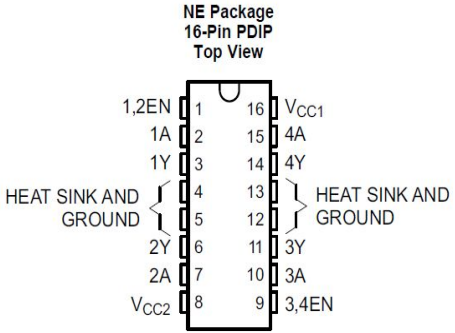


Truth Table

Pin 1	Pin 2	Pin 7	Function
High	**High**	**Low**	**Turn Anti-clockwise (Reverse)**
High	**Low**	**High**	**Turn clockwise (Forward)**
High	**High**	**High**	**Stop**
High	**Low**	**Low**	**Stop**
Low	**X**	**X**	**Stop**

High ~+5V, Low ~0V, X=Either high or low (don't care)

L293D Motor Driver Pin Diagram



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
1,2EN	1	I	Enable driver channels 1 and 2 (active high input)
<1:4>A	2, 7, 10, 15	I	Driver inputs, noninverting
<1:4>Y	3, 6, 11, 14	O	Driver outputs
3,4EN	9	I	Enable driver channels 3 and 4 (active high input)
GROUND	4, 5, 12, 13	—	Device ground and heat sink pin. Connect to printed-circuit-board ground plane with multiple solid vias
V_{CC1}	16	—	5-V supply for internal logic translation
V_{CC2}	8	—	Power VCC for drivers 4.5 V to 36 V

1,2EN: To activate the channel 1 and 2 we supply +5v to this pin.

3,4EN: To activate the channel 3 and 4 we supply +5v to this pin.

Vcc1: Input voltage to derive the internal circuit (darligton array) = 4.5 to 36 v

Vcc2: Supply/Output to appear at output = 4.5 to 36 v

1A: Channel-1 Input Pin

2A: Channel-2 Input Pin

3A: Channel-3 Input Pin

4A: Channel-4 Input Pin

1Y: Channel-1 Output Pin

2Y: Channel-2 Output Pin

3Y: Channel-3 Output Pin

4Y: Channel-4 Output Pin

L293D IC Specifications

- Supply Voltage Range 4.5V to 36V
- 600-mA Output current capability per driver
- Separate Input-logic supply
- It can drive small DC-geared motors, bipolar stepper motor.
- Pulsed Current 1.2-A Per Driver
- Thermal Shutdown
- Internal ESD Protection
- High-Noise-Immunity Inputs

Code

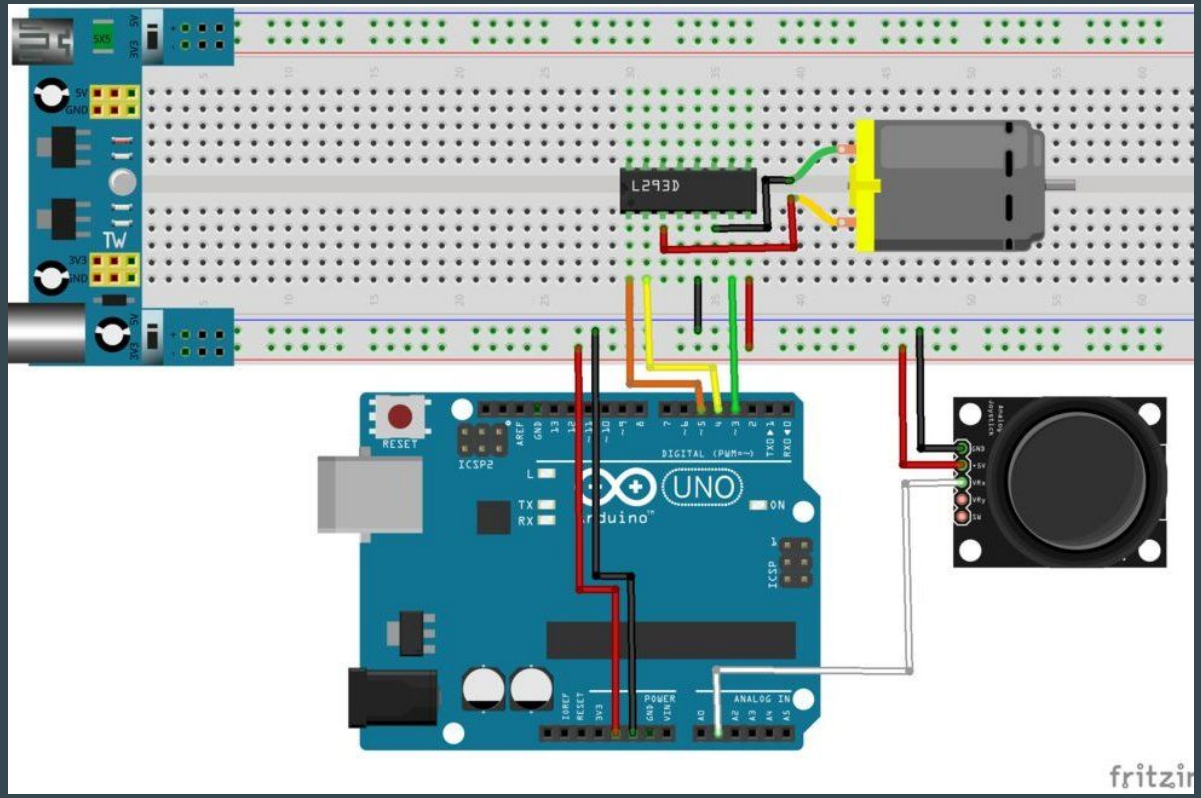
```
/*
  This example use the Y-axle of joystick to control the DC Motor
*/

const int Y_pin = 1; // analog pin connected to Y output

#define ENABLE 5
#define DIRA 3
#define DIRB 4

int i;

void setup() {
  //---set pin direction
  pinMode(ENABLE,OUTPUT);
  pinMode(DIRA,OUTPUT);
  pinMode(DIRB,OUTPUT);
  Serial.begin(9600);
}
```

```
oid loop() {
    long y;
  y = analogRead(Y_pin);
  Serial.print("val=");
  Serial.println(y);
  if(y == 0){
    analogWrite(ENABLE,255);
    digitalWrite(DIRA,LOW); //one way
    digitalWrite(DIRB,HIGH);
    }
  if(y>0&&y<100){
    analogWrite(ENABLE,200);
    digitalWrite(DIRA,LOW); //one way
    digitalWrite(DIRB,HIGH);
    }
  if(y>100&&y<250){
    analogWrite(ENABLE,180);
    digitalWrite(DIRA,LOW); //one way
    digitalWrite(DIRB,HIGH);
    }
  if(y>250&&y<400){
    analogWrite(ENABLE,128);
    digitalWrite(DIRA,LOW); //one way
    digitalWrite(DIRB,HIGH);
    }
```

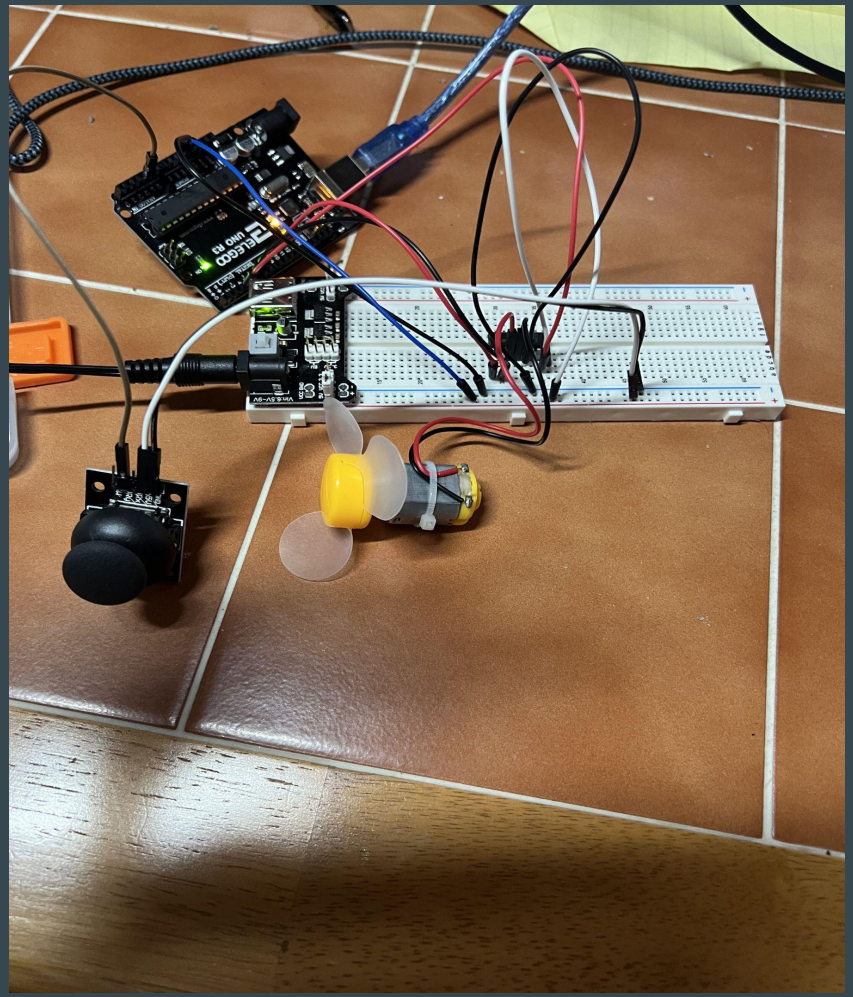
More code

```
if(y>400&&y<500){
  analogWrite(ENABLE,80);
  digitalWrite(DIRA,LOW); //one way
  digitalWrite(DIRB,HIGH);
  }
 if(y>500&&y<600){
  analogWrite(ENABLE,0);
  digitalWrite(DIRA,LOW); //one way
  digitalWrite(DIRB,HIGH);
  }
 if(y == 1023){
  analogWrite(ENABLE,255);
  digitalWrite(DIRA,HIGH); //revers
  digitalWrite(DIRB,LOW);
  }
 if(y>800&&y<923){
    analogWrite(ENABLE,180);
    digitalWrite(DIRA,HIGH); //revers
    digitalWrite(DIRB,LOW);
    }
  if(y>700&&y<800){
    analogWrite(ENABLE,128);
    digitalWrite(DIRA,HIGH); //revers
    digitalWrite(DIRB,LOW);
    }
  if(y>600&&y<700){
    analogWrite(ENABLE,80);
    digitalWrite(DIRA,HIGH); //revers
    digitalWrite(DIRB,LOW);
    }
}
```

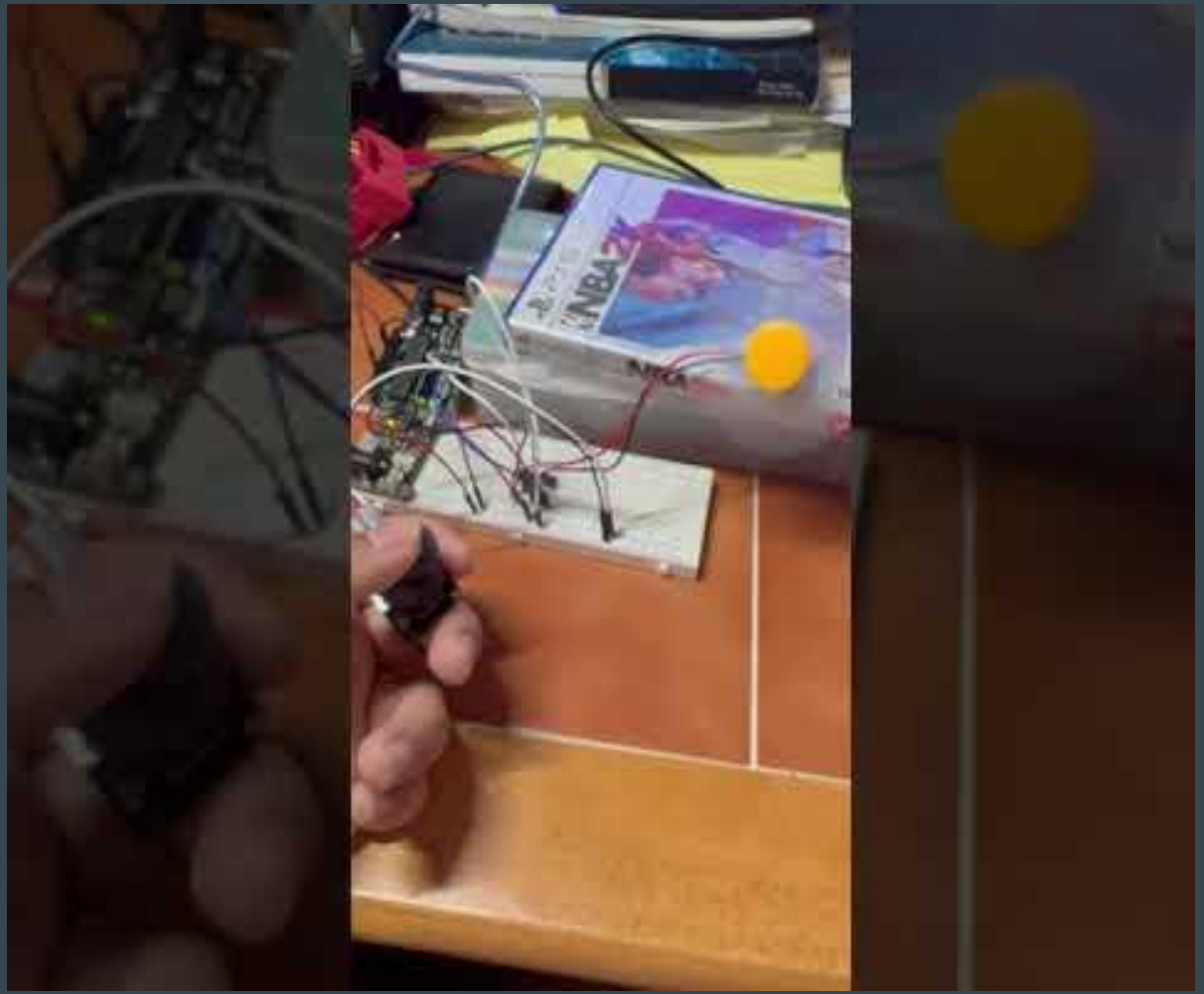
Schematic


L293D
RESET
ICSP2
UNO
DIGITAL (PWM~)
POWER
ANALOG IN
ICSP
fritzing

Setup



Demonstration



Future Improvements

- We can try to connect the joystick to the DC motor wirelessly using Bluetooth.
- DC Motor wires should be longer for more versatile placing.
- We can use this project to make a smart RC car using Arduino.

References

1) https://www.processingmagazine.com/pumps-motors-drives/article/15586862/the-dc-motor-advantage?fbclid=IwAR3O2Ff-hBRCYhsMZAJhRhdG0T1L2TJ9U45oWqHw3BgNztW1H9mM_GjrKhA
2) https://create.arduino.cc/projecthub/binsun148/fun-projects-with-elegoo-uno-r3-super-start-kit-joystick-9b09e6?fbclid=IwAR06Kl_DIG5LFHyxxDGftiEIkEJeSLdWmDjEygE-a4sXvMhOI1bdwwvSD3w
3) https://www.arduino.cc/documents/datasheets/H-bridge_motor_driver.PDF
4) https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.brainkart.com%2Farticle%2FClassification-and-Types-of-DC-Motor_6662%2F&psig=AOvVaw2vlJj8n0EsaWDpUgeyM8Fw&ust=1638928053911000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCOCmkPbI0PQCFQAAAAAdAAAAABAb
5) https://www.google.com/url?sa=i&url=http%3A%2F%2Fwww.rs-online.com%2Fdesignspark%2Fdifferent-types-of-motors-and-their-use&psig=AOvVaw0nyjhdiIlfIOIwfY9Mlbmg&ust=1638928150500000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCJC6oaTJ0PQCFQAAAAAdAAAAABAD
6) https://www.ti.com/lit/ds/symlink/l293.pdf
7) https://www.google.com/url?sa=i&url=https%3A%2F%2Felec-club-iitb.github.io%2Fblog%2F2016%2F08%2Fl293d%2F&psig=AOvVaw0a3o-zAQWnKOQ2fgxssq-p&ust=1638998785846000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCKjUvrXQ0vQCFQAAAAAdAAAAABAD
8) https://osoyoo.com/2017/10/10/arduino-lesson-l293d-with-dc-motor/
9) https://e2e.ti.com/blogs_/b/analogwire/posts/what-you-need-to-know-about-internal-esd-protection-on-integrated-circuits