DEPARTMENT OF MECHATRONICS ENGINEERING

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

SEM 2 - 2023/2024

Task #1: Comparison of Motors for Embedded System Applications

MCTE 4342 – EMBEDDED SYSTEM DESIGN

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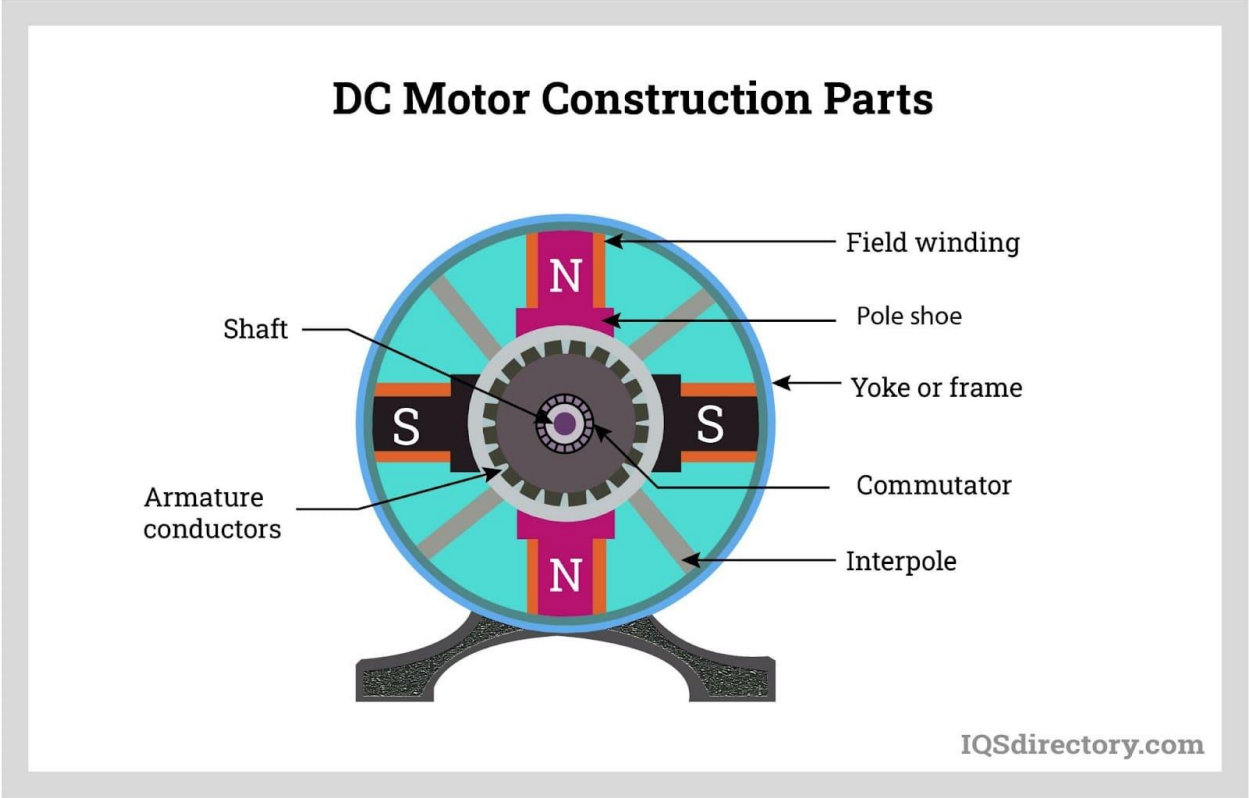
Matric NO.:

1820413

CHAPTER 1: DC MOTORS

1.1 Image/Picture:



1.2 Common Uses in Robots:

1- Propulsion systems for mobile robots (wheels and tracks)

2- Actuating mechanisms (arms and grippers)

1.3 Advantages:

1- Simple control mechanisms (just need to control voltage/current)

2- High rotational speed (RPM)

3- Inexpensive and widely available

4- Easy to implement for beginners

1.4 Disadvantages:

1- Lack of precise control without additional components (like encoders)

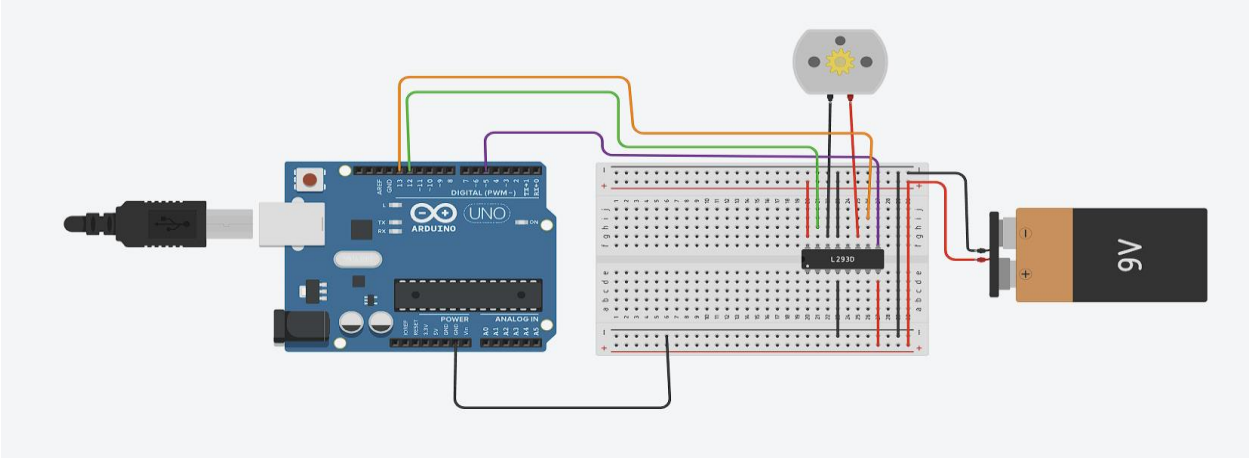
2- Can wear out faster due to brushes

3- Inefficient compared to brushless motors

4- Requires continuous power to maintain position

1.5 Interfacing with Arduino:

1.5.1 Wiring Diagram:



1.5.2 Components:

- Arduino Uno
- DC Motor
- L298N Motor Driver
- Power Supply (battery)
- Breadboard and jumper wires

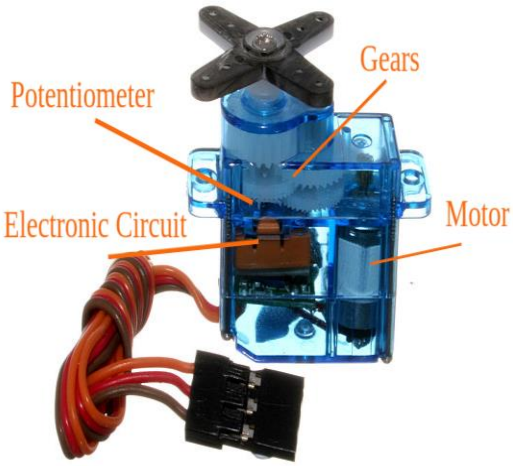
1.6 Coding Sample:

sketch_may16a.ino

```
int enA = 9;
int in1 = 8;
int in2 = 7;

void setup() {
  pinMode(enA, OUTPUT);
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  analogWrite(enA, 255); // Full speed
}

void loop() {
  // No code in loop
}
```

CHAPTER 2: SERVO MOTORS

2.1 Image/Picture:



2.2 Common uses in Robots:

1- Joint control for robotic arms

2- Pan/tilt mechanisms for cameras

3- Control surfaces on robots (e.g., rudders, ailerons)

2.3 Advantages:

1- High precision in position control

2- Good torque

3- Easy to control with PWM signals

4- Holds position with no extra power

2.4 Disadvantages:

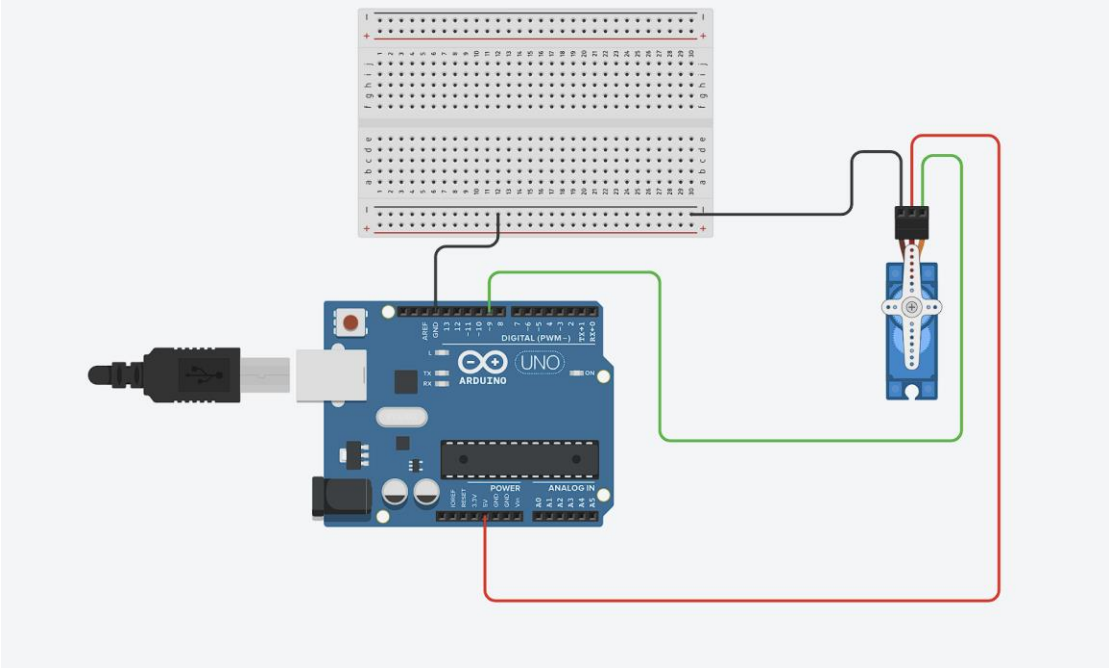
1- Limited rotation angle (usually 180 degrees or less)

2- More expensive than simple DC motors

3- Lower speed compared to DC motors

2.5 Interfacing with Arduino:

2.5.1 Wiring Diagram:



2.5.2 Components:

- Arduino Uno
- Servo Motor
- External power supply (if needed)
- Breadboard and jumper wires

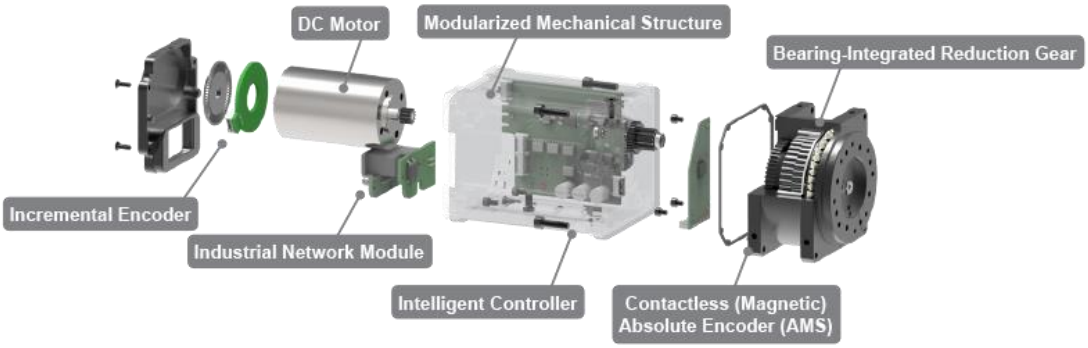
2.6 Coding Sample:

sketch_may16a.ino

```ino
#include <Servo.h>

Servo myservo;
int pos = 0;

void setup() {
  myservo.attach(9);
}

void loop() {
  for (pos = 0; pos <= 180; pos += 1) {
    myservo.write(pos);
    delay(15);
  }
  for (pos = 180; pos >= 0; pos -= 1) {
    myservo.write(pos);
    delay(15);
  }
}
```

CHAPTER 3: DYNAMIXEL SERVO

3.1 Image/Picture:



3.2 Common uses in Robots:

1- Advanced robotic arms

2- Humanoid robots

3- Hexapod robots

3.3 Advantages:

1- High precision and torque

2- Integrated feedback and control

3- Daisy-chain connection for multiple servos

4- Durable and reliable

3.4 Disadvantages:

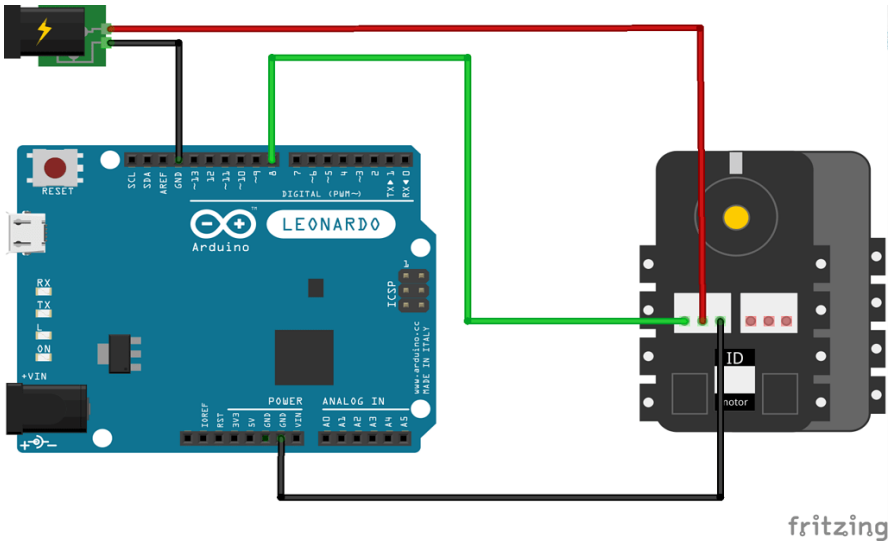
1- Expensive

2- More complex to interface with than simple servos

3- Requires dedicated libraries and possibly a USB2Dynamixel adapter

3.5 Interfacing with Arduino:

3.5.1 Wiring Diagram:



3.5.2 Components:

1- Arduino Uno

2- Dynamixel Servo

3- USB2Dynamixel adapter or similar

4- Breadboard and jumper wires

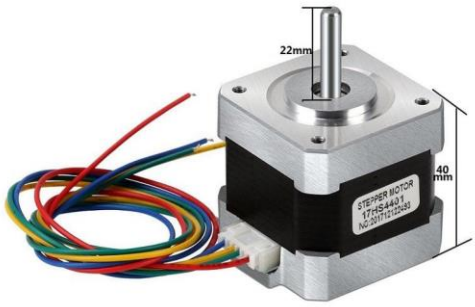
3.6 Coding Sample:

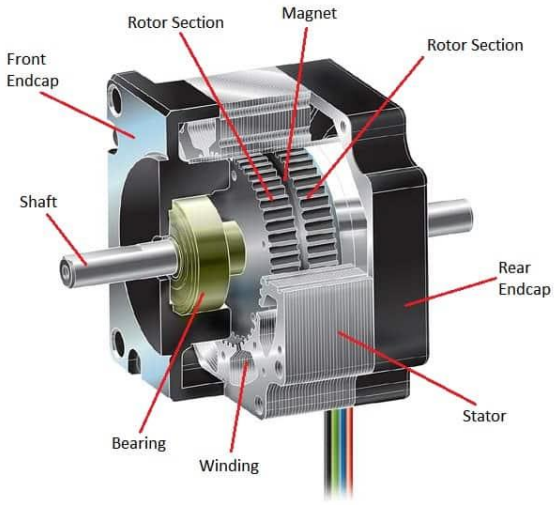
sketch_may16a.ino

```ino
#include <DynamixelShield.h>

DynamixelShield dxl;

void setup() {
  dxl.begin(57600);
  dxl.setPortProtocolVersion(2.0);
  dxl.torqueOn(1);
}

void loop() {
  dxl.setGoalPosition(1, 512); // Middle position
  delay(1000);
  dxl.setGoalPosition(1, 1023); // Maximum position
  delay(1000);
}
```

CHAPTER 4: STEPPER MOTORS

4.1 Image/Picture:





4.2 Common Uses in Robots:

1- Precise positioning tasks

2- CNC machines

3- 3D printers

4- Camera sliders

4.3 Advantages:

1- Precise control over position

2- Good torque at low speeds

3- Can maintain position without power

4.4 Disadvantages:

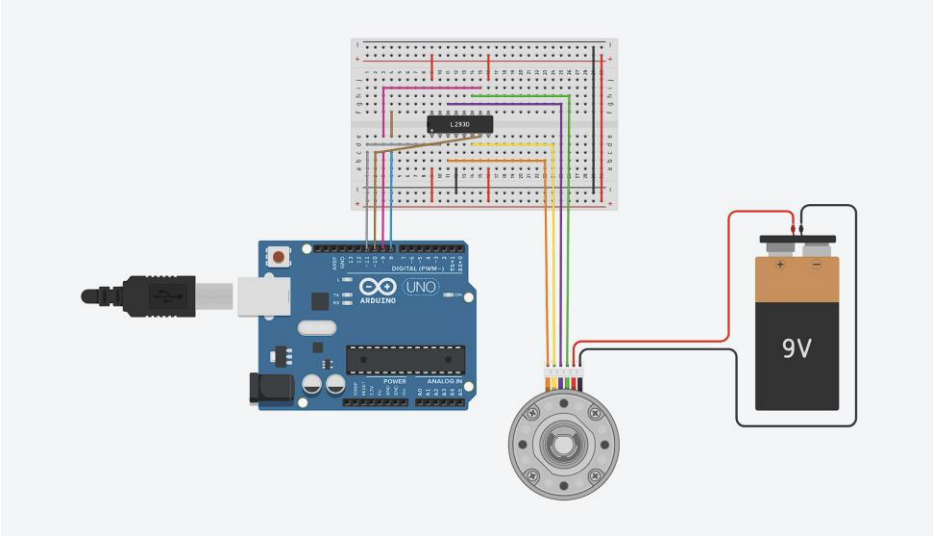
1- Complex control (requires stepper driver)

2- Lower speed compared to DC motors

3- Can lose steps if overloaded

4.5 Interfacing with Arduino:

4.5.1 Wiring Diagram:



4.5.2 Components:

1- Arduino Uno

2- Stepper Motor

3- L293D Driver

4- Power supply

5- Breadboard and jumper wires

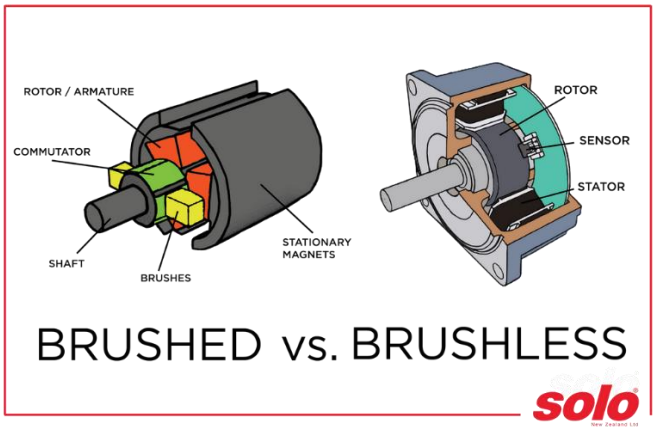
4.6 Coding Sample:

sketch_may16a.ino

```
#include <Stepper.h>

const int stepsPerRevolution = 200;

Stepper myStepper(stepsPerRevolution, 8, 9, 10, 11);

void setup() {
  myStepper.setSpeed(60);
}

void loop() {
  myStepper.step(stepsPerRevolution);
  delay(1000);
  myStepper.step(-stepsPerRevolution);
  delay(1000);
}
```

CHAPTER 5: BRUSHLESS MOTORS

5.1 Image/Picture:



5.2 Common Uses in Robots:

1- Drones

2- High-speed applications

3- Electric vehicles

5.3 Advantages

1- High efficiency

2- Long lifespan due to lack of brushes

3- High power-to-weight ratio

4- Quiet operation

5.4 Disadvantages:

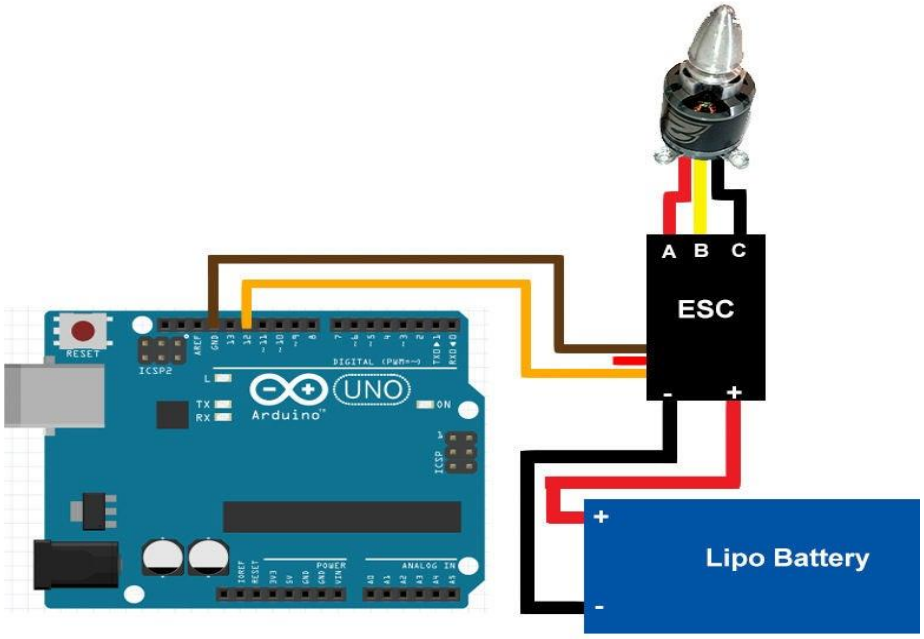
1- Requires electronic speed controller (ESC)

2- More complex to control

3- Higher initial cost

5.5 Interfacing with Arduino:

5.5.1 Wiring Diagram:



5.5.2 Components:

1- Arduino Uno

2- Brushless Motor

3- Electronic Speed Controller (ESC)

4- Power supply

5- Breadboard and jumper wires

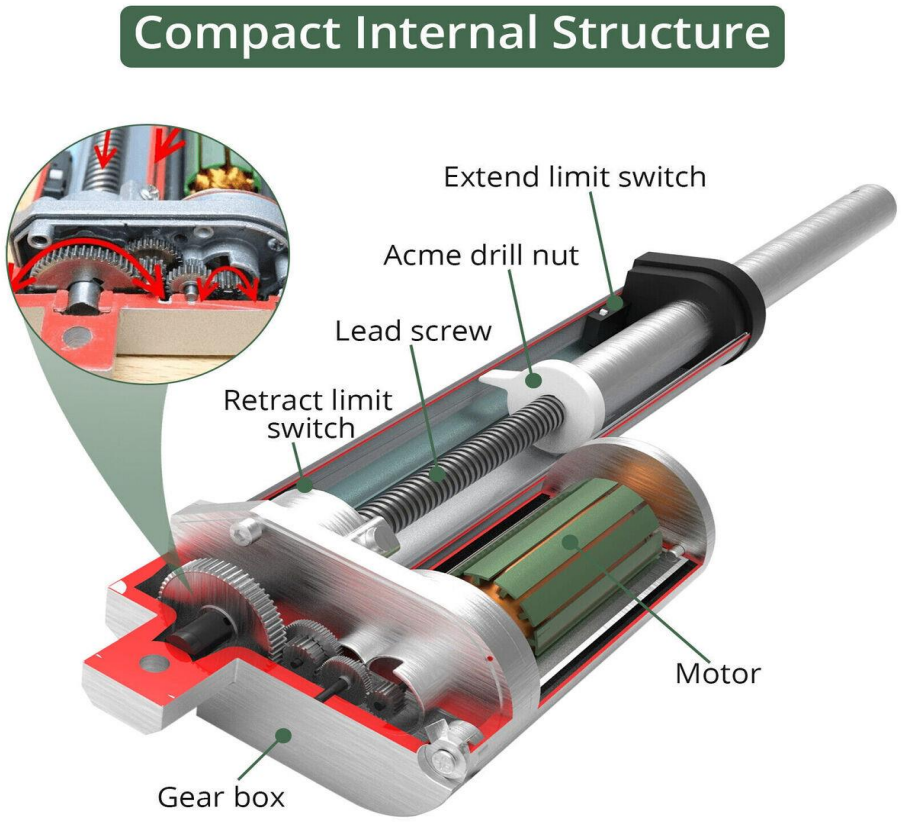
5.6 Coding Sample:

sketch_may16a.ino

```
int motorPin = 9;

void setup() {
  pinMode(motorPin, OUTPUT);
}

void loop() {
  analogWrite(motorPin, 128); // 50% duty cycle
  delay(1000);
  analogWrite(motorPin, 255); // 100% duty cycle
  delay(1000);
}
```

CHAPTER 6: LINEAR ACTUATOR MOTORS

6.1 Image/Picture:



6.2 Common uses in Robots:

1- Linear motion tasks

2- Heavy lifting

3- Industrial automation

6.3 Advantages

1- High force output

2- Precise linear movement

3- Easy to control with simple on/off or PWM

6.4 Disadvantages:

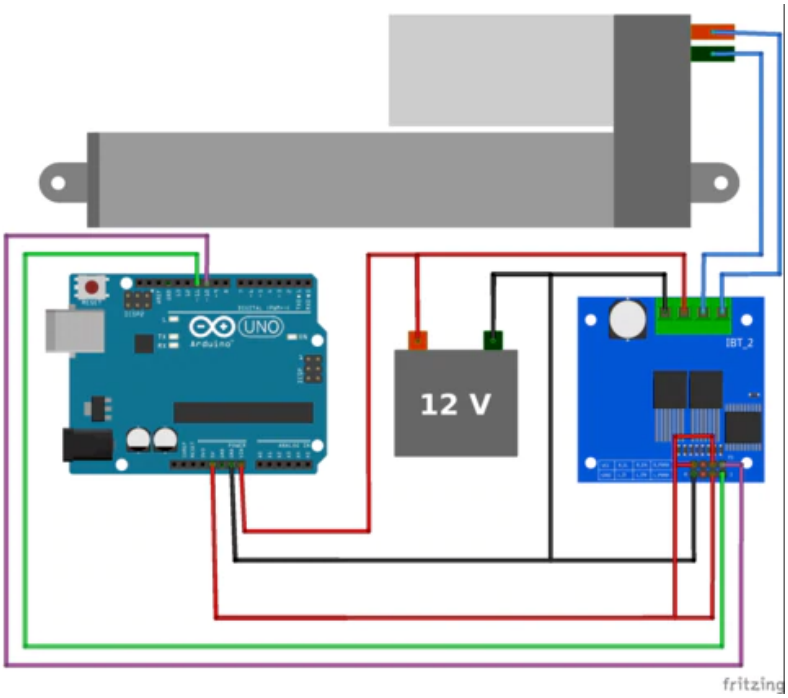
1- Slow speed

2- More expensive than rotary motors

3- Larger form factor

6.5 Interfacing with Arduino:

6.5.1 Wiring Diagram:



6.5.2 Components:

1- Arduino Uno

2- Linear Actuator

3- H-Bridge Motor Driver

4- Power supply

5- Breadboard and jumper wires

6.6 Coding Sample:

sketch_may16a.ino

```
int motorPin = 9;

void setup() {
  pinMode(motorPin, OUTPUT);
}

void loop() {
  digitalWrite(motorPin, HIGH);
  delay(2000);
  digitalWrite(motorPin, LOW);
  delay(2000);
}
```