Equipment Report

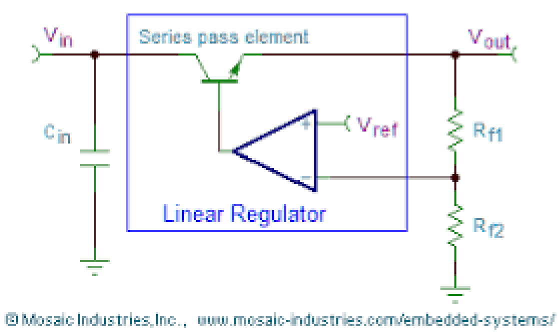
Batteries:

Lithium-ion/Lithium polymer batteries:

- Energy-dense: Store a lot of energy for the amount of weight
- Expensive
- Very commonly used in laptops, phone, EV
- Available in wide range of form factors
- 1200 mAh capacity (can pull 1.2 A for an hour before they die)
- 3.7V nominal voltage (voltage put out when 50% charged)
- We need to use two of them to get 7.4V because of motor requirements
- Dangerous (handle carefully)

Voltage Regulators:

- To stabilize power source (keeps voltage at steady level preventing voltage drops due to microcontrollers, motors etc. so that they run efficiently) (burns off excess voltage)
- Linear voltage regulators (kind of variable resistance)



- Through-hole component
- 3.3V, 800mA output current (due to controller requirements, note that motor requires more power and will use power directly from battery instead of using it from the regulator)
- LD1117 (VR)
- Additional by pass capacitors to be used to form low pass filter to keep voltage level smooth

Softwares:

- Autodesk Inventor
- ROS
- Arduino IDE
- Autodesk Eagle (PCB)
- Tinker CAD

Motors:

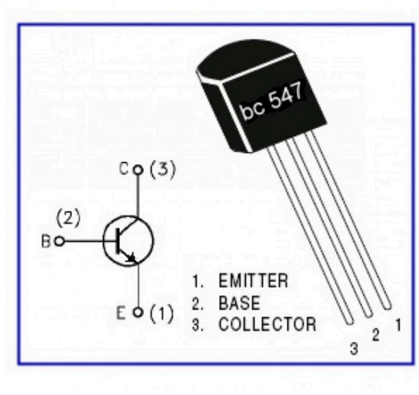
Two types: Brushed and Brushless motors

- We can use brushed motors even though they are lesser efficient because we do not require very high speed. They are much more simpler.
- 30:1 Gear Ratio (30 rotations of driver gear leads to one full rotation of driven gear) (This ratio needed because if there was no gear box then the motor would spin too fast due to no torque and wouldnt stop immediately as well. This ratio means we have 30 times more torque)
- 6V ideal operating voltage
- Max current drawn is 0.67 A

Motor Control:

Controlling motor state:

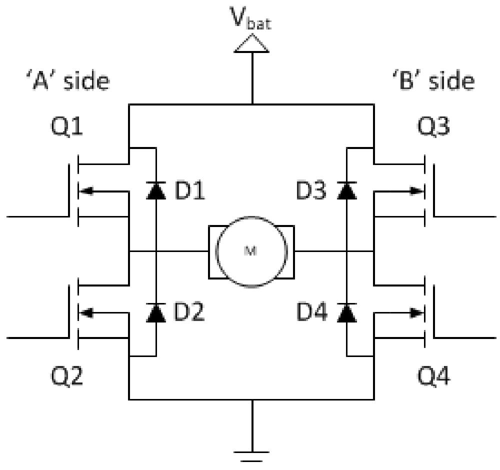
- Cannot connect the motor directly with MCU because not enough voltage or current supply available from it. Motors require 6V and can draw up to 0.67A, whereas MCU can supply 3.3V and low current (mA).
- Hence, we can use NPN transistor (when voltage applied to base, current will flow from emitter to collector) to connect battery and ground. Microcontroller output pin used to control ON/OFF state of transistor allowing power flow between battery and motor.



- Motor will create magnetic field (inductance). Hence turning it off results in a temporary voltage spike to maintain current (back emf). Hence, we use a flyback diode (since it allows current to flow in only one direction). This is to protect equipment.

Controlling motor direction:

- Basic motor controller called H-Bridge. It consists of four transistors and four flyback diodes. Can control the direction of motor by turning ON/OFF particular transistors.
    1. Q1 and Q4 ON: current flows through the motor to the right.
    2. Q2 and Q3 ON: current flows through the motor to the left
    3. All ON: short circuit (don't do it)



- Dual H-Bridge (One IC to control two motors)
  Four inputs: each input is connected to two transistors (i.e. input 1 turns on Q1 and Q4)
  Four outputs: two outputs to connect to each motor
  Enable pins: activate the H-Bridge and allow us to turn on the transistor

L293D motor driver (no solder component hence easy to remove and replace if accidentally burnt)

Controlling motor speed:

- We can mix on and off inputs to create a range of voltages to be used to control the speed. Motors have inertia and hence will be slow to respond to rapid voltage changes.
- PWM (Pulse Width Modulation) can be used.
  Note: Duty cycle: % of time in the ON state
  Frequency: No. of cycles per second
  Duty cycle will represent the speed.
- MCU Clock speed 16MHz
- H-Bridge Max Frequency 5kHz
- Counter Period: 16MHz / 5kHz = 3200 clock cycles
  Pulse Value: CLock cycles to stay on per period
  Here, for a 75% duty cycle: 2400 clock cycles on, 800 off

Encoders:

To measure how far and fast the mouse has travelling. They continually measure the rotation of the motor. There are two types of encoders: Magnetic and Optical Encoders. We plan to use Magnetic Encoders.

- Magnetic encoders work on the principle of the Hall Effect (Production of a voltage difference from a current and a magnetic field).
- Will sense change in rotational position as motor spins.
- 6 pole magnetic disk (60 degrees between each pole)
  2 Hall effect Sensors (90 deg between each sensor)
  Hence
- Detects the presence of a magnetic field