# DESIGN OF A MULTI FUNCTIONAL MOBILE ROBOT


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# COMPETITION OVERVIEW

- Five Events
  - The Tennis Ball Throw
  - The Golf Hit
  - The Lift
  - The Sprint
  - The Stair Climb

Figure 1: American Society of Mechanical Engineers

- Project Objective
  - Design a multi-functional robot capable of lifting, throwing, and hitting while maintaining a high degree of mobility

# COMPETITION CONSTRAINTS

- 50 cm x 50 cm x 50 cm Box
  - Must contain:
    - Robot
    - Weight to be lifted
    - Batteries
    - Controller
- All Energy Must Be Returned To Its Original Form
  - This includes:
    - Compressed Air
    - Springs

# PROJECT OVERVIEW

- Background Research
- Brainstorming
- Design Generation
- **Component Selection**
- **Preliminary Testing**
- Assembly
- Optimization
- Compete
- Win

Current Standing

Future Progress

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# DESIGN SELECTION

## House of Quality

- Success is dependent on:
  - Power consumption
  - Mass of lifted object
  - Strength of frame
  - Battery capacity

## Morphological Chart/ Pugh Matrix

- Primary Power Sources: Electric/Compressed Air
- Hit: Golf Club Head on Vane Actuator
- Sprint: Pneumatic Projectile
- Climb: Chaos Frame
- Lift: Pneumatic Pistons
- Throw: Air Cannon

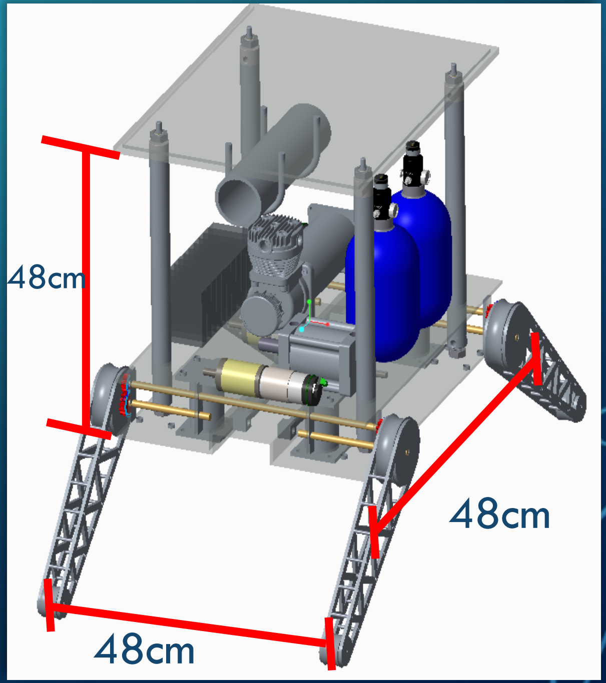


Figure 2: Original Design Selection

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# STRESS ANALYSIS: VON–MISES STRESS

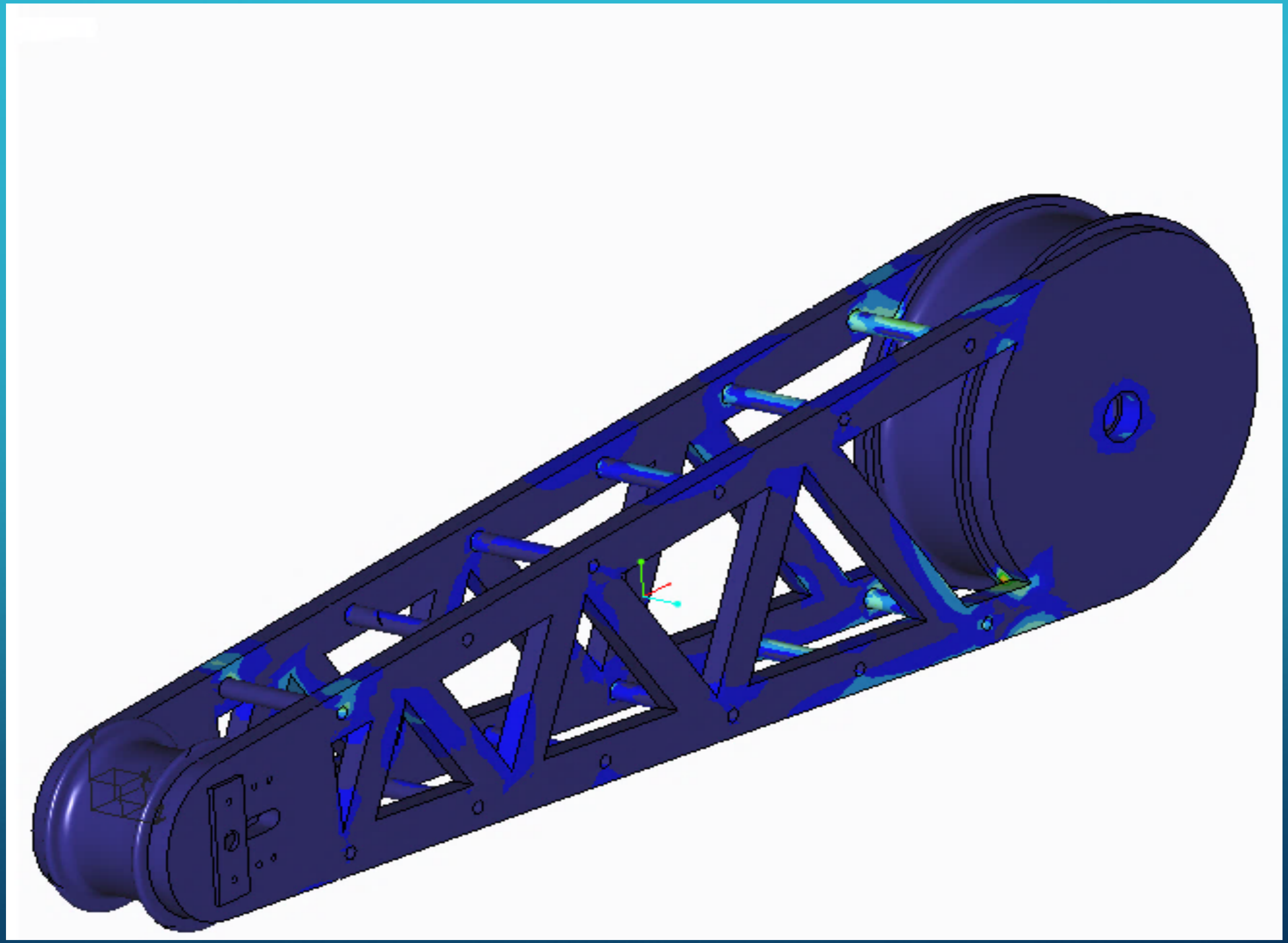
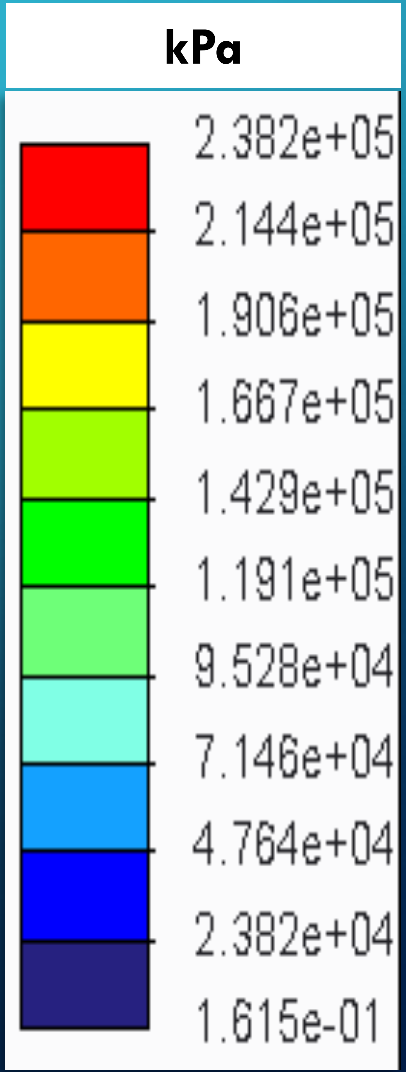


Figure 3: Stress Analysis on Track Arm

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# FURTHER DESIGN CONSIDERATIONS

- The Lift
  - Air Jacks
    - Less expensive
    - Lower level of complexity
- Object To Be Lifted
  - Modular weight
- The Sprint
  - Motorized Measuring Tape Concept


Figure 4: BushRanger Air Jack

# FURTHER DESIGN CONSIDERATIONS

- The Throw
  - Cannon testing
    - Preliminary prototype
- The Climb
  - Tread selection
    - Cost effective
    - Flexible

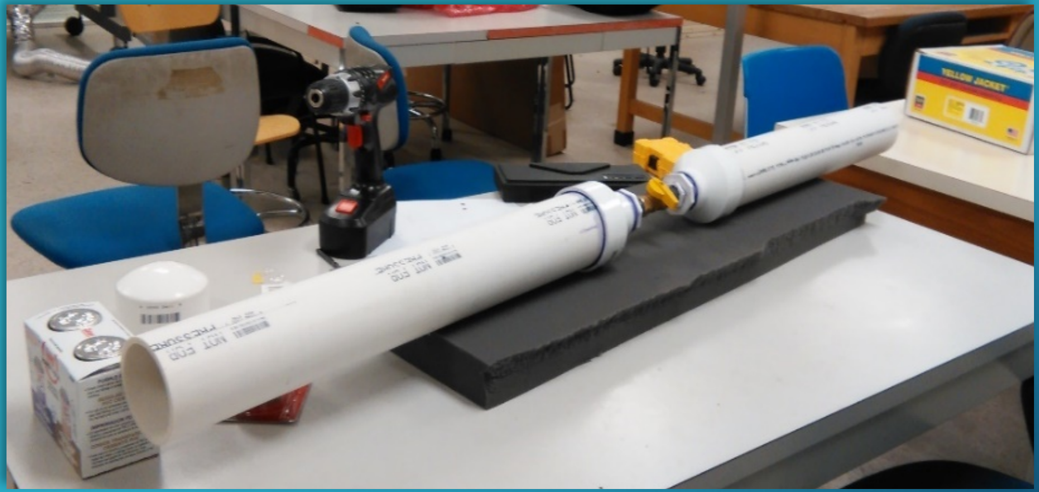

Figure 5: Cannon Test Rig

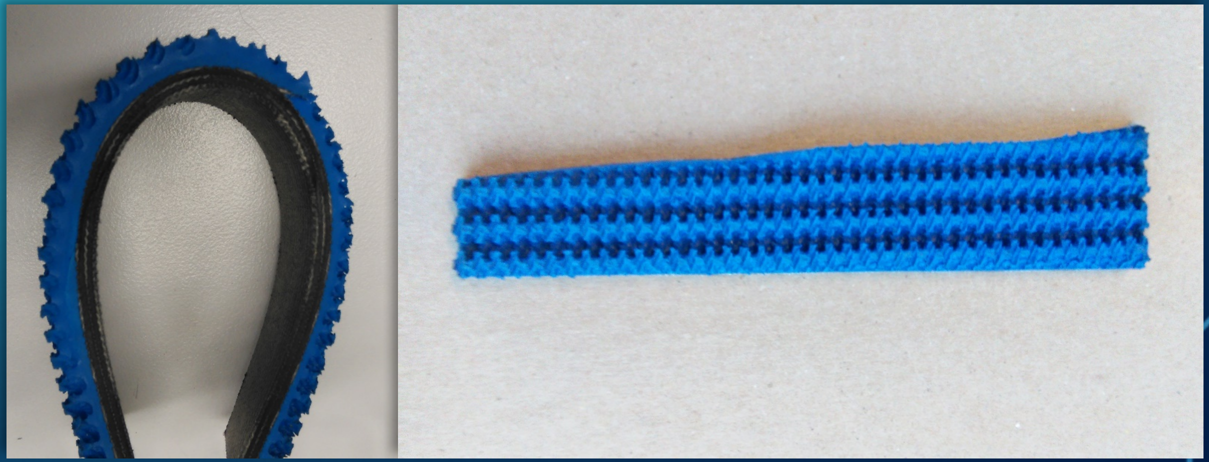

Figure 6: Tread Material Sample

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# USB SHIELD ARDUINO MICROCONTROLLER

- Can communicate and support USB Hub Functions.
- Power
  - 500mA max current when powered by power supply.
  - Lightweight with a 5V operating voltage.
- For relay-based DC motor control applications.
- Six pins for PWM.

Figure 8: Arduino Uno Microcontroller

Figure 7: USB Bluetooth Dongle

# USB SHIELD ARDUINO MICROCONTROLLER – CONT'D.

- Hosts an external power supply along with a USB hub and Vin pin for power
- Supplies 14 digital pins/6 power pins/6 analog pins
- Digital pins can be used as I/O pins

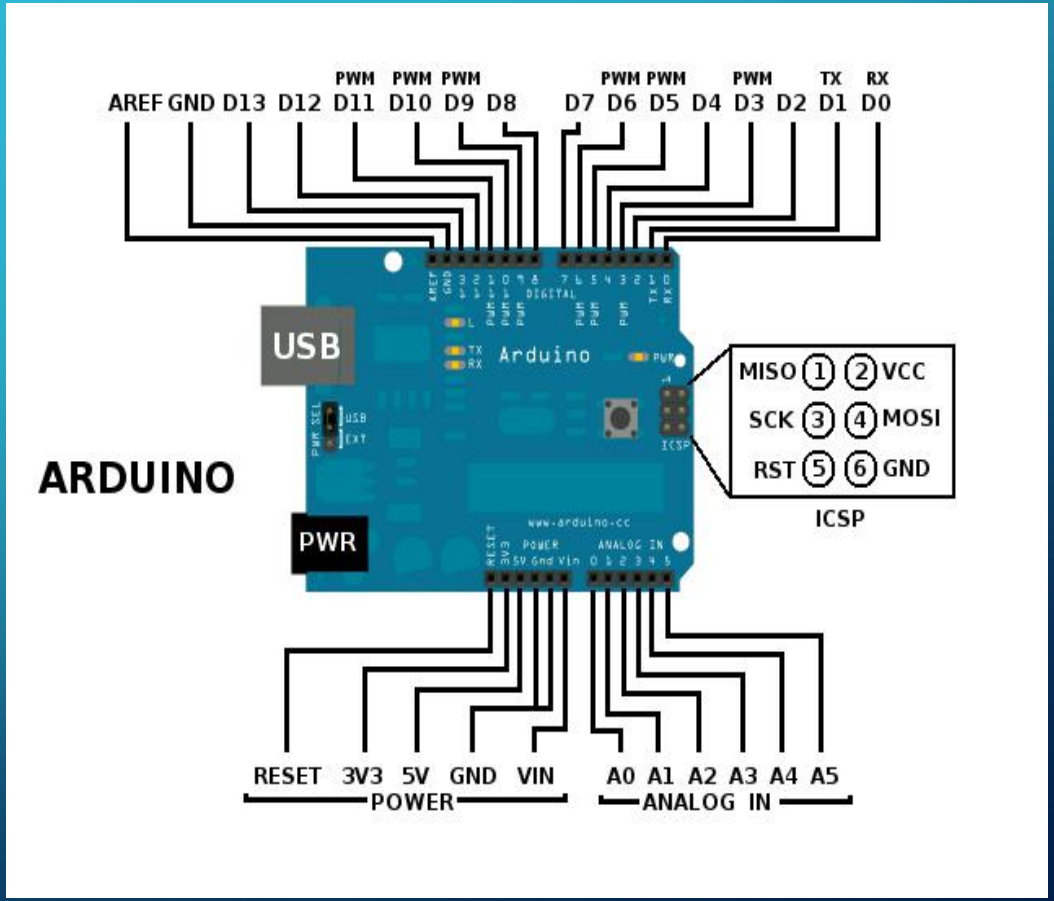


Figure 9: Pin I/O Assignment

# CODING/TESTING MICROCONTROLLER

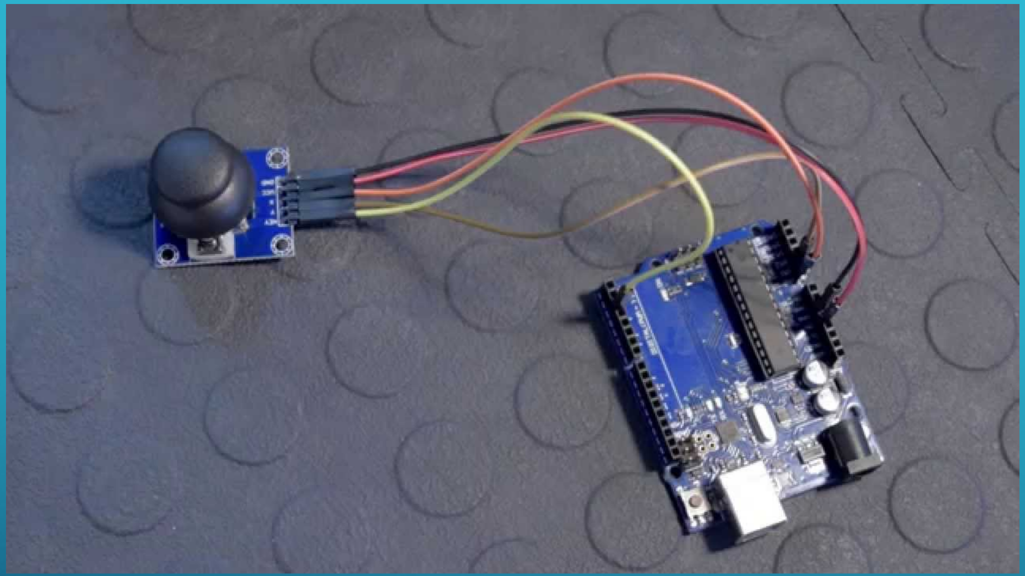

Figure 10: Joy Stick sensor connected to arduino MCU

- Coding/Debugging the microcontroller to control our robot
- Checking on the efficiency of every event based on the given code and electrical components used
- Determining the sensitivity of our controls with respect to the potentiometer

# PULSE WIDTH MODULATION (PWM) FOR DC MOTOR

- Input To Output For DC Motors
- Playstation 3 Six-Axis Controller

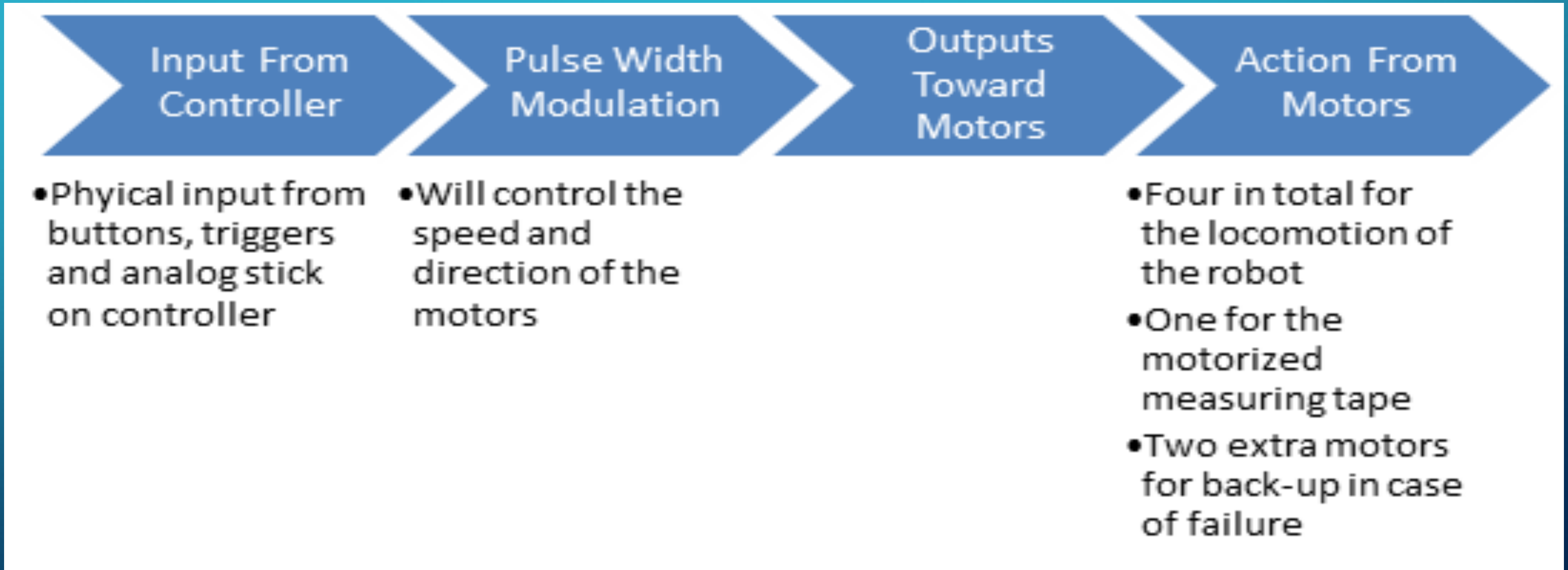


Figure 11: Flow Chart of PWM Motor based on user input

# MOTOR SELECTION

- Primary Motor
  - 9015 motor with a 27:1 planetary gearbox
  - Used to control the tracks on the arms
  - Speed is determined based on sensitivity of the analog stick on controller
  - Events
    - Sprint and Stair climb


Figure 12: 9015 Motor

- Secondary Motor
  - RS775 motor with a 188:1 planetary gearbox
  - Used to control the rotation of the arms
  - Can rotate the arm 360° clockwise or counter-clockwise.
  - Events
    - Stair climb and Hit

Figure 13: RS775 Motor

# MOTOR CONNECTIONS

- Operation
  - 12V source
  - 5V input signal
    - Encoders for channel A and B
- Direction Of Shaft Rotation
  - Based on direction of current flow into the device

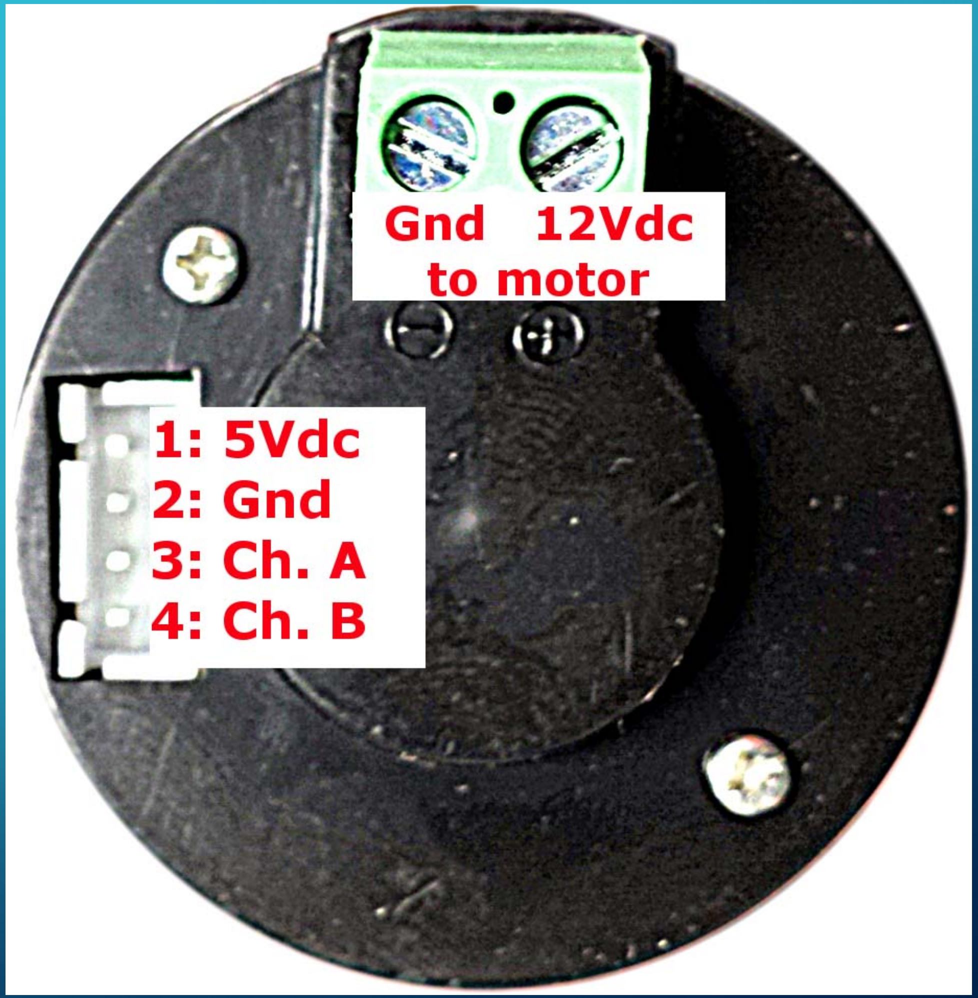


Figure 14: Pin I/O Assignment

# BATTERIES

- Lithium Polymer Batteries
    - Small dimensions
    - Quickly recharge
    - High energy density
- Alternative Choice: Nickel Metal Hydride
    - Discharge rate
    - User friendliness
        - Much safer

Figure 15: Lithium Polymer Battery

# DESIGN SPECIFICATIONS

- Multiple Batteries In Parallel
  - Increase the current output
  - Balance between efficiency and power consumption
  - Disadvantages
    - More to recharge
    - Self discharge
    - Specific charging requirements
    - Several parts will stop working at different times

# RELAY CIRCUIT

- General Purpose Motor Relay Circuit
  - Electromechanical switch at 12V
  - Synchronizes two motors for movement
- Effective Switching Mechanism
  - Each motor connected to relay circuit
  - Effective in setting up controller
  - Isolating and catching faults during commands
- Low Power Signal
  - Used to control the circuit

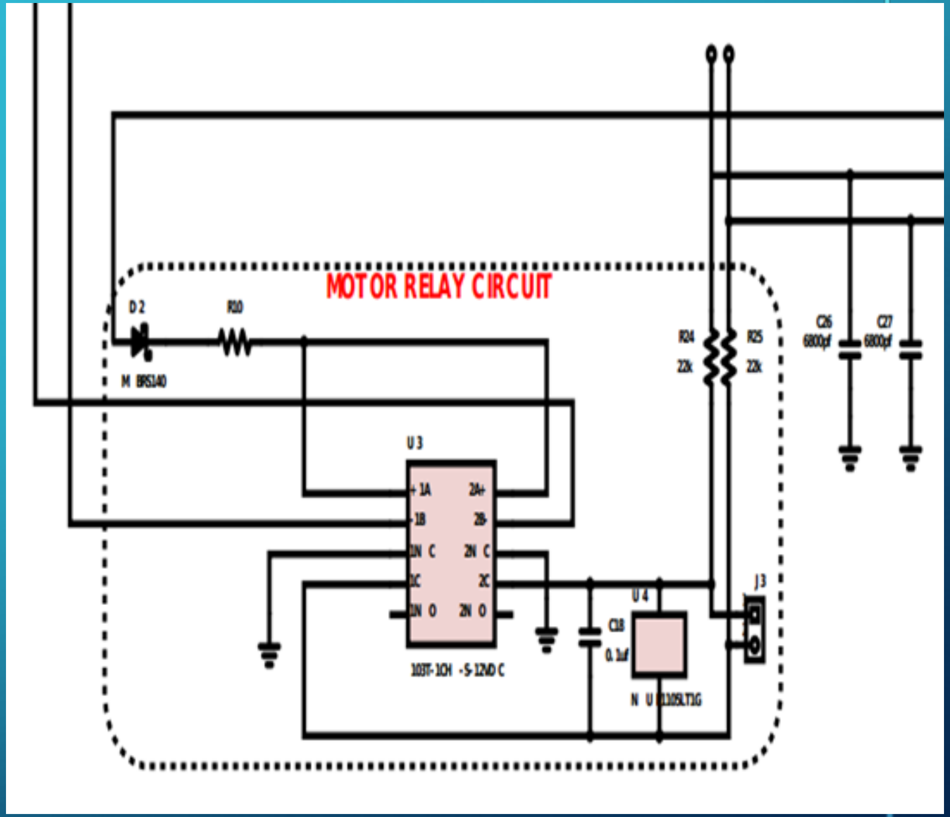


Figure 16: Motor Relay Circuit Diagram

# FUTURE GOALS

- Short-Term Goals
  - Prototyping
    - Event Prototyping
  - Finalizing Component Selection
    - Order necessary parts
  - Stress/Failure Analysis
    - Machining/Manufacturing
- Long-Term Goals
  - Assembly
  - Preliminary platform testing

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# QUESTIONS?