Title
Fluid Powered Vehicle Challenge: Zotdraulics

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Fluid Powered Vehicle Challenge: Zotdraulics

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Executive Summary: The National Fluid Power Association hosts the Fluid Power Vehicle Challenge, a competition that challenges students to create a vehicle powered by hydraulic components. The competition consists of 4 events, which respectively test the speed, endurance, efficiency, and regenerative braking capabilities of the vehicle. Zotdraulics is creating a tricycle that translates human input into hydraulic power, focusing on speed and endurance.

Objectives

Our primary aim is to build a trike with an integrated hydraulic system which can operate in three states (**Direct drive, Charging and Regenerative Braking**). We also seek to build a **foundational understanding** which **future UCI Teams** may build upon.

Team Contribution

- **Adrian Jimenez:** Design for Mounting and Hydraulic System
- **Ben Trejo:** Drivetrain component selection and analysis
- **Elaine Kwok:** Design for Mounting and Hydraulic System
- **Ian Lin:** Sponsor point of contact, Design for Hydraulic System
- **Karen Gines:** CAD Design, Documentation
- **Steven Tsui:** Controls, Electronics

Shortcomings

1. Timeline: **Longer material lead times** than expected, delayed timeline -> delay in activities
2. Testing: **Incomplete Testing** for the fully assembled vehicle. Next 2 weeks leading to competition will be fully dedicated to testing and troubleshooting to ensure functional vehicle.

Societal Impact/Safety

Societal impact: Garner more interest in hydraulics
Safety concerns: High pressures in hydraulic components are potential hazards

Future Improvements

1. Design a **custom vehicle frame** with a more centralized center of gravity
2. Implement a **real-time data logging system** for pressure, speed and efficiency analysis
3. Incorporate a **multi-speed gearbox** that allows for quick and easy gear ratio changes between competition events

Key features: Hydraulic Circuit

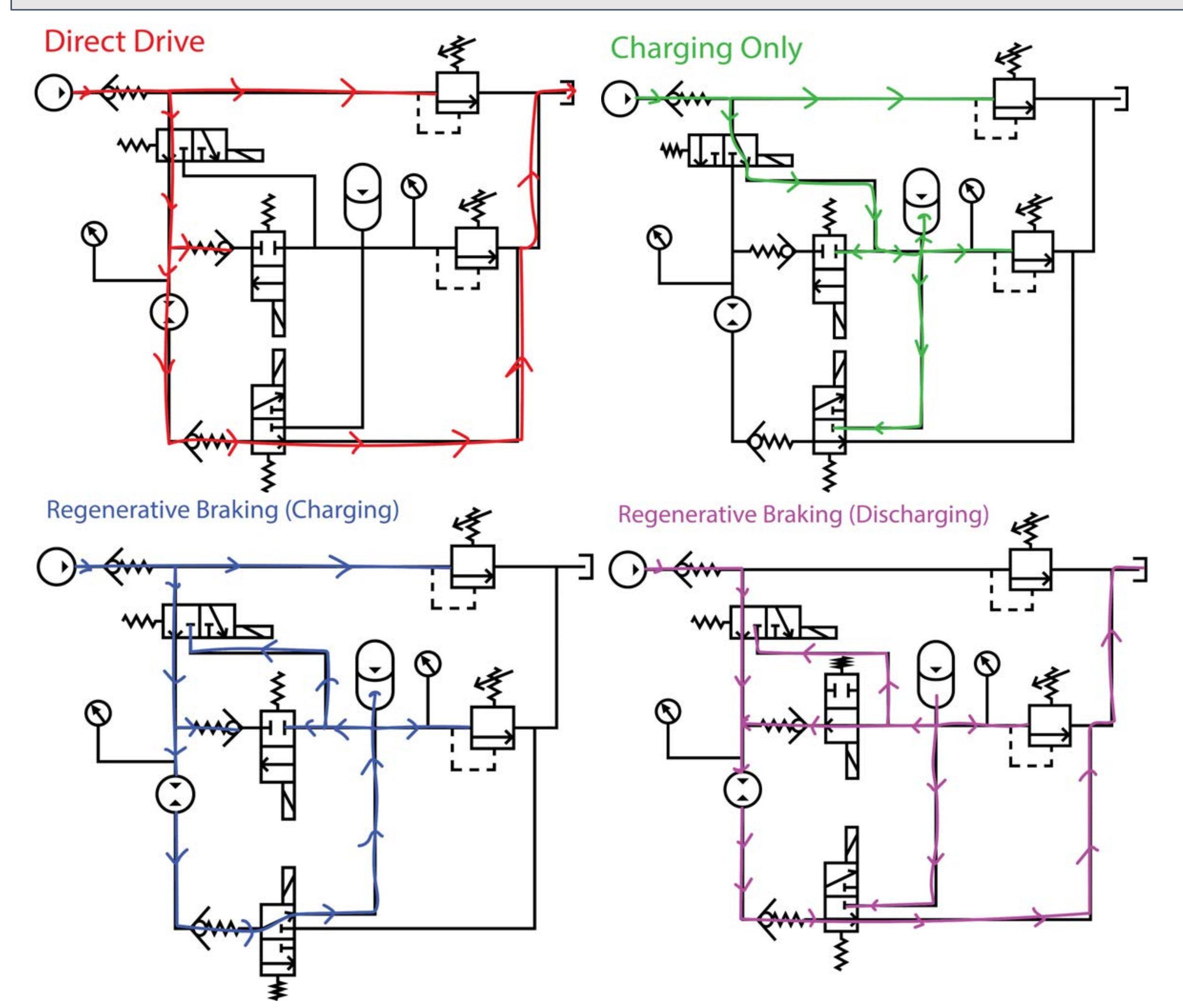

Figure 1. Pressure Lines for 4 Circuit States

The **manifold is the heart of the tricycle**. It houses a circuit which allows the rider to reroute hydraulic fluid by actuating 3 solenoid valves to achieve different drive states:

1. **Direct drive**:
   Pedals > Pump > Motor > Reservoir
2. **Charging only**:
   Pedals > Pump > Accumulator
3. **Regen. Braking Charge**:
   Pedals > Pump > Motor > Accumulator
4. **Regen. Braking Discharge**:
   Accumulator > Motor > Reservoir

Design Analysis

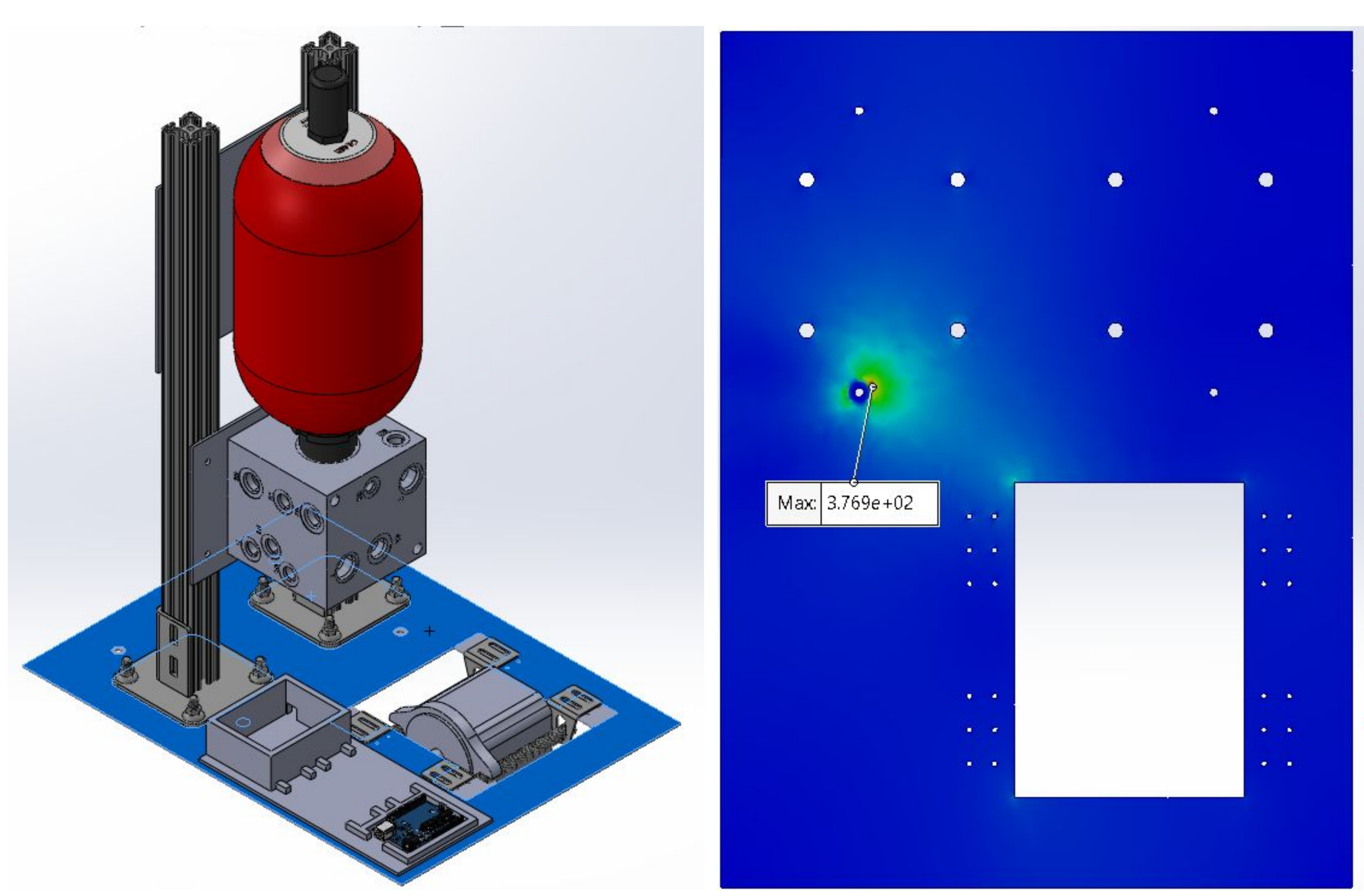

Figure 2. Component Mounting Configuration and Stress Analysis of Base Plate

Stress analysis of **base plate** carrying key components like **manifold** (cube), **accumulator** (gas container), **motor**, and **control box**. High stresses in Y-direction led to design choice of **¼" 5052 H32 Aluminum**.

Figure 2 shows a stress concentration near a fixture point for the base plate. A max stress of **95 MPa** is recorded in the Y-direction, well under the **193 MPa** yield strength of our chosen material.

Key Features: Electronics

1. Functionality: Switching between Drive States using Toggle Switches
2. User Experience: Displaying Pressure and Speed Readings on LCD Screen

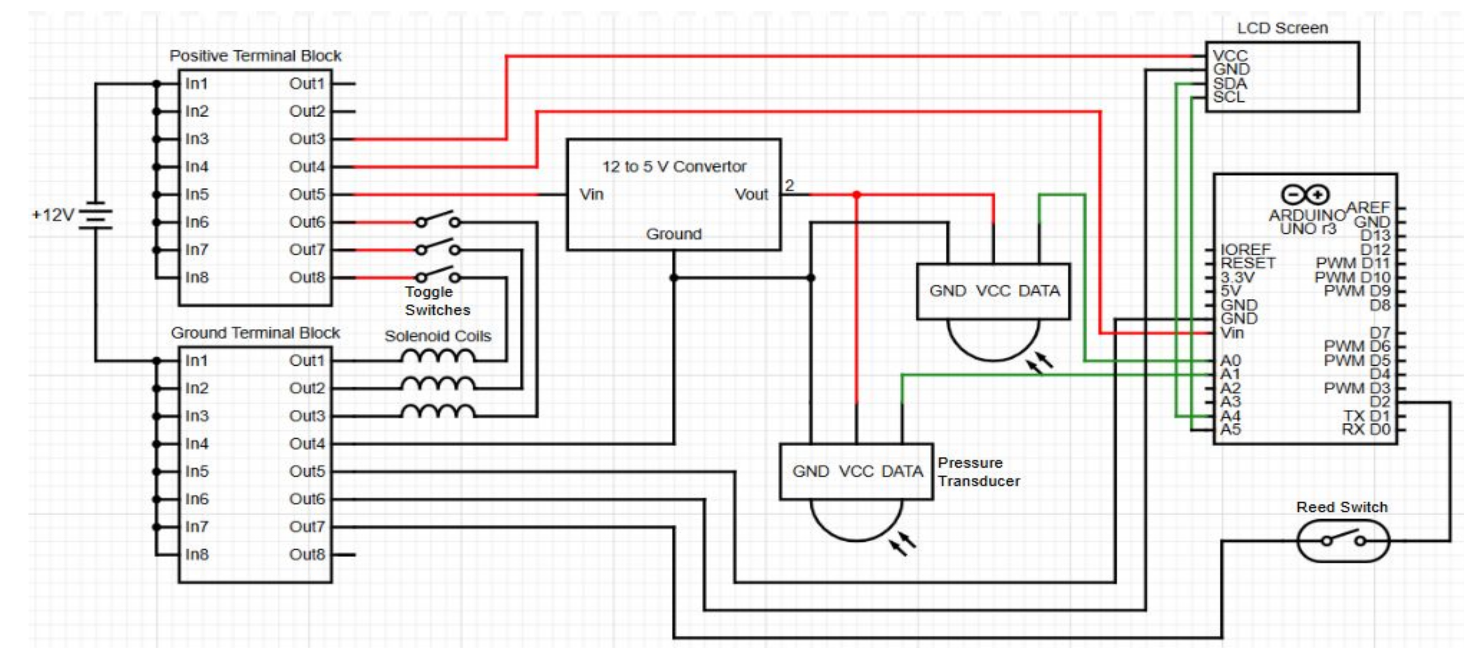

Figure 3. Electronics Circuit Diagram

Final Design

Figure 4: Full Trike Assembly

Manufacturing:
1. Trike from Schwinn weighs approx. 60 lbs
2. Hydraulic System weighs approx. 55 lbs altogether.
3. Custom mounts made of 5052 H32 Aluminum
4. Flexible tubing for all lines
5. Danfoss Gear Motor with 1 CIR, and Danfoss Pump with 0.5 CIR
6. Drivetrain system: 4:1 Gear Ratio from Pedal to Pump, 2:1 Gear Ratio from Motor to Rear Axle

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