Fluid Power Vehicle Challenge

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Introduction

This project's goal is to design a vehicle to compete in a Fluid Power Vehicle Challenge. The vehicle must transmit power via a hydraulic system. This is done by transmitting energy from the rider, through the hydraulic system, and releasing it as kinetic energy that turns the wheels. The vehicle must also be able to recover energy through regenerative braking and quickly release that energy to move the vehicle forward without any additional exertion from the rider. The other objectives of this project are as follow:

- Continue the previous team path to build a better design
- Participate in the Fluid Power Vehicle challenge
- Gain experience and build a good networking with industry
- Give recommendations to the next team

Challenge Description

Sprint Race: Timed 600 ft race using pressure discharge and direct drive mode.

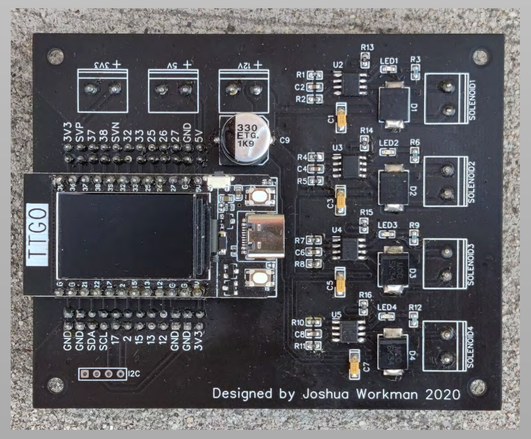
Efficiency challenge: The vehicle is driven by energy in accumulator. The efficiency score is calculated from the weight, precharge pressure, and distance traveled.

Endurance challenge: Timed 1 mile race. Regenerative braking must be demonstrated with a complete stop.

Design Overview

The design of our vehicle is centered around three different systems: the hydraulic system, electronic control system, and the mechanical system. The hydraulic system consists of four different modes (Drive Mode, Turbo Mode, Regenerative Braking Mode, and Direct Charge Mode). These modes are toggled by the Electronic system using solenoid-operated hydraulic valves. Additionally, we designed, simulated and manufactured a custom tricycle frame.

Electronic Control System

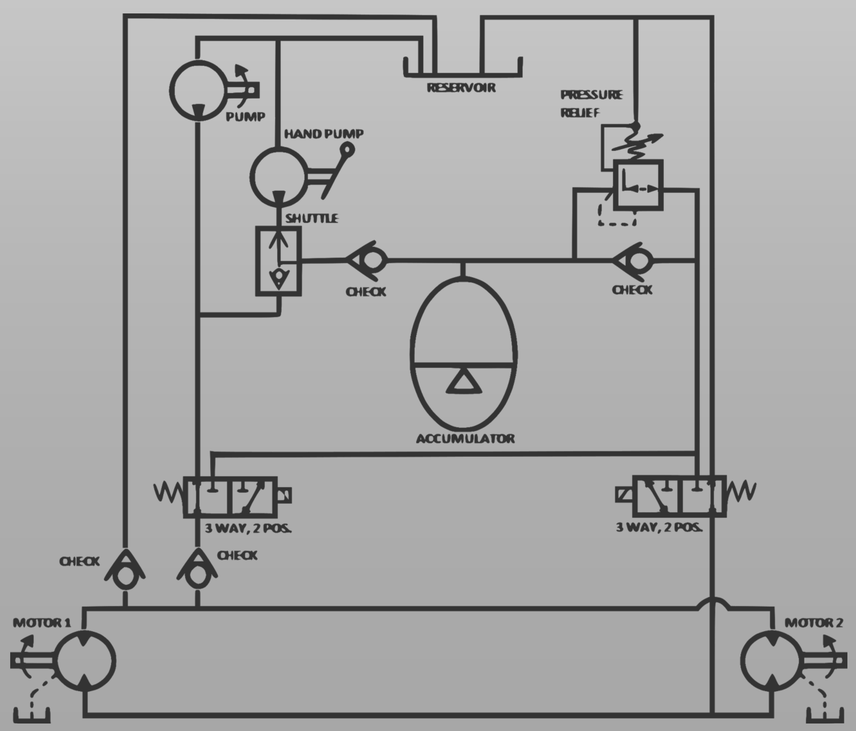


A custom printed circuit board (PCB) was designed to operate the hydraulic system. It uses 4 DRV103H high power solenoid drivers to switch the valves in the hydraulic circuit. A TTGO T-Display Arduino-based microcontroller switches the solenoid drivers on and off via the handlebar control buttons or over a bluetooth connection to a smartphone. An embedded screen provides visual feedback to the user. Power is supplied to the system by a Dewalt 20V battery, stepped down to the appropriate levels via two buck converters.

Hydraulic System

The Hydraulic System transmits power from the rider to the vehicle. It primarily utilizes energy provided by pedaling or the energy stored in an *accumulator*, the hydraulic equivalent of a capacitor. This system can be reconfigured dynamically for four different modes to strategically perform well in the competition: Drive Mode (standard pedaling), Turbo Mode (using the accumulator), Regenerative Mode (using the motors to brake and recharge the accumulator), and Direct Charge Mode (using both the pedals and hand pump to pressurize the accumulator).

Hydraulic Schematic



Mechanical System

The assembly of our vehicle consisted of the following:

- Welding aluminum tubes for the frame
- Mounting hydraulic components
- Connecting components with fittings and hoses

Conclusion:

This vehicle is designed to be able to compete in the NFPA's Fluid Power Vehicle Challenge and meet all of the requirements therein. The bicycle provided a way for a single rider to move themselves forward by creating energy in the form of hydraulic pressure and releasing it as kinetic energy. The bicycle is able to store energy with regenerative braking, and be able to quickly release that energy to move the bicycle forward without any additional exertion from the rider. The specifications of the vehicle are as follow:

Objective	Metric	Scale
Cost	US Dollar	$3978
Top Speed	mph	25
Horsepower	hp	0.533
Weight	lbs	195.8