



Project Sponsored by ARUS MR TECH
Utilizing AMT-DAMPRO+ Magnetorheological Fluid

PROJECT MOTIVATION

Apply existing MR damping technology to MTB suspension

Explore a new semi-active damping approach for bicycles



Image Source: Vexels

WHY IS DAMPING IMPORTANT?

- Improves traction and overall control
- Provides greater comfort for riders
- Allows high-performance athletes to go faster, providing a competitive edge

EXISTING MR SYSTEMS

AUTOMOTIVE SUSPENSION

Used to actively dissipate vibrations caused by the road

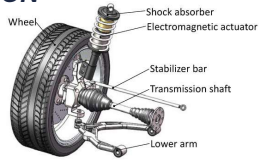


Image Sources: Wei W et al. (top); Senqia (bottom)



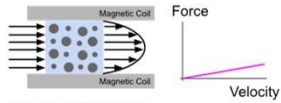
SEISMIC DAMPERS

Used to actively absorb kinetic energy produced during earthquakes

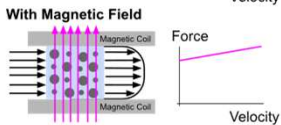
KEY TECHNOLOGY

MAGNETORHEOLOGICAL (MR) FLUID

Without Magnetic Field

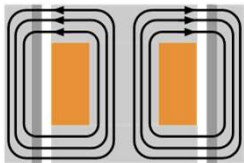


- Microscopic iron particles suspended in a carrier fluid
- Newtonian fluid behavior until a field is present; becomes a Bingham plastic



ELECTROMAGNETISM

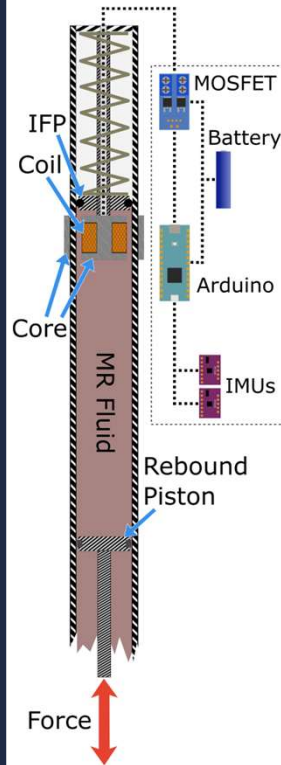
- Electric current creates a magnetic field when wound into a coil
- Stronger field → greater damping force



PRODUCT

This project provides an **alternative damping approach** using MR fluid and electromagnetic control to enable **real-time, hands-free damping adjustment** in a front suspension fork

EMBR DAMPER



CONTROL SYSTEM

- Relies on 2 accelerometers to track the relative motion of the uppers and lowers
- Controls the electromagnet in real time

MECHANICAL

- Flow restriction via an annular gap
- Steel E-mag core
- Fully sealed Internal Floating Piston (IFP)
- Re-valved rebound circuit

ELECTROMAGNET

- Creates a strong magnetic field through the annular gap, perpendicular to the direction of fluid flow
- Magnetic flux path is channeled through steel components
- Designed to consider space restrictions, power draw, and heat generation



COST ANALYSIS

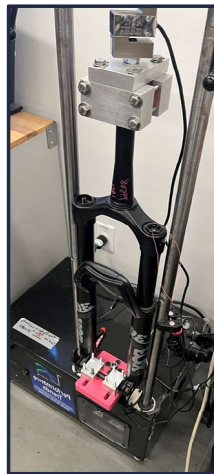
| Model | Price | Weight (g) |
|---------------------------------|--------|------------|
| EMBR Fork | \$1400 | 2360 |
| RockShox Lyrik Flight Attendant | \$1700 | 2340 |
| Fox 36 Factory Live Valve | \$1600 | 2140 |

The complete EMBR fork is similar in weight while undercutting competitors on price

TESTING & VALIDATION

VERIFICATION

CFD models used to simulate annular gap geometry and verify various piston diameters



VALIDATION

Dynamometry used to measure damper performance with respect to velocity

| Axle Velocity [m/s] | Plane Poiseuille Flow Model [N] | Ansys Fluent CFD [N] | Model Difference |
|---------------------|---------------------------------|----------------------|------------------|
| 2 | 20 | 16 | 16.5 % |
| 4 | 45 | 40 | 10.9 % |
| 6 | 80 | 74 | 7.2 % |

