Designing and Testing a Prototype Automatic Electronic Control System for Active Magnetic Levitation of a Ferromagnet Towards Magnetically Deflected Ballistic Mass Technology

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Magnetically deflected ballistic mass (MBDM) describes a system in which a metal rotor, the mass in the system, is suspended inside an evacuated sheath like a maglev train. The metal rotor can be accelerated to high speeds in the nearly frictionless environment, allowing storage of energy in the movement of the rotor with minimal energy losses over time. MDBM has many promising applications. One is in large-scale energy storage, which can supplement intermittent power sources like wind and solar. Another application is in launching aircraft and spacecraft; this system removes the chemical fuel for takeoff from the vehicle itself, circumventing the rocket equation. Additionally, MDBM could be used to launch aircraft from aircraft carriers at higher throughput. This project takes the first step towards MDBM technology by designing and testing a non-linear active control system for a simulated MDBM environment. A mild-carbon steel disc was selected as the ferromagnetic test object. The electronics used were an Arduino Mega, Arduino UNO, L298N motor driver, 24V DC power supply, and two 24V DC electromagnets. The sensor system was an analog rotary potentiometer integrated with the test rig and ferromagnet by a lever system. This control system can power the electromagnets at 256 different steps using PWM, allowing for precise control of the electromagnets' power at speeds much faster than can be manually achieved. The control algorithm, which is a heavily modified PID algorithm, can bring large displacements to within an average +-0.5mm of the setpoint in 227ms and fine-tune the correction to within an average of +-0.06mm of the setpoint within another 10.318 seconds. As such, it is a successful prototype that can be implemented in a future MDBM system with minimal tuning.

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