Helical Coil Acceleration System

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Abstract

This project presents a flat helical electromagnetic launch system that accelerates a projectile using multiple electromagnetic coils activated in sequence.

Unlike traditional linear launchers the helical design increases the acceleration path within a compact area providing nearly 300% more distance for acceleration.

The system uses synchronized magnetic pulses generated by coils placed along the spiral path to continuously propel the projectile. Sensors and timed activation ensure smooth motion and stable acceleration during operation.

The proposed design improves acceleration efficiency, enhances energy transfer, and reduces system size by arranging all coils on a single flat level. Experimental evaluation showed better acceleration and propulsion performance compared to conventional linear and single coil electromagnetic launch systems.

Introduction / Background

Traditional launch systems rely mainly on chemical propulsion which can be expensive, non reusable, and harmful to the environment. As a result electromagnetic launching systems have become a promising alternative that offers greater control and higher efficiency in high speed acceleration applications.

Compared to railgun systems, coilgun based launchers provide better sustainability due to lower mechanical wear and reduced structural damage during operation.

This project focuses on developing a multi coil electromagnetic acceleration system based on a flat helical design. The proposed geometry increases the acceleration path within a compact area while improving projectile motion stability.

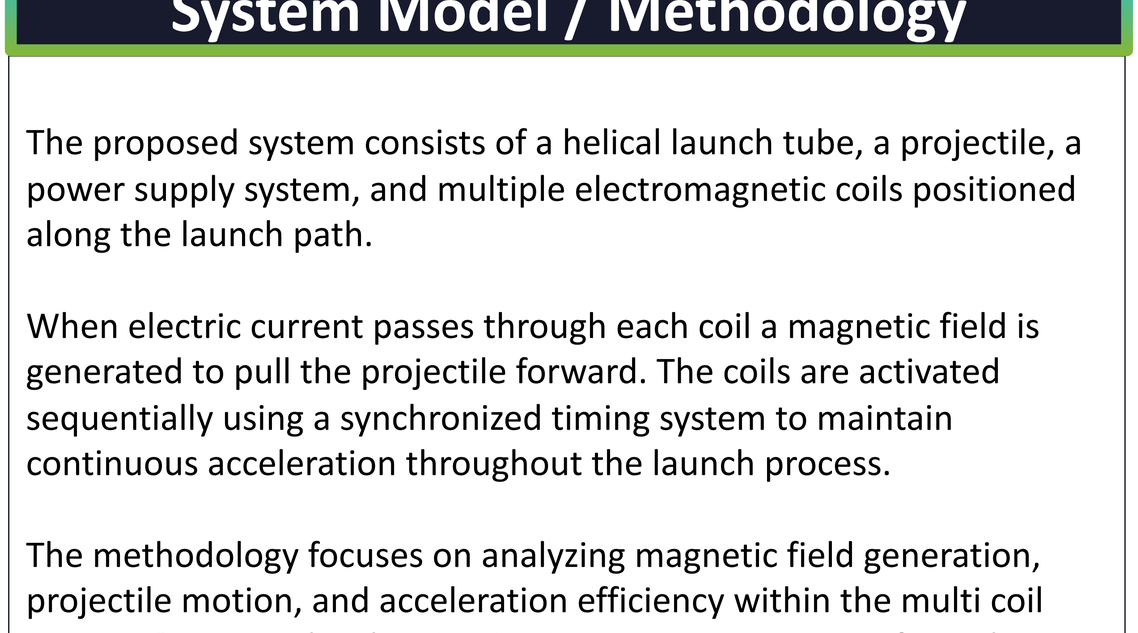
Sequential activation of the electromagnetic coils generates synchronized magnetic fields that continuously accelerate the projectile and enhance propulsion efficiency throughout the launch process.

System Model / Methodology

The proposed system consists of a helical launch tube, a projectile, a power supply system, and multiple electromagnetic coils positioned along the launch path.

When electric current passes through each coil a magnetic field is generated to pull the projectile forward. The coils are activated sequentially using a synchronized timing system to maintain continuous acceleration throughout the launch process.

The methodology focuses on analyzing magnetic field generation, projectile motion, and acceleration efficiency within the multi coil system. Sequential coil activation improves energy transfer, enhances propulsion stability, and reduces energy loss during operation.



Proposed Solution / Main Idea

Problem Statement:
Traditional propulsion systems and conventional railguns often rely on chemical propellants or high-friction linear stages, leading to significant environmental degradation through toxic gas emissions and chemical explosions. Furthermore, these systems suffer from limited distances relative to their physical size and high operational costs due to material wear and energy inefficiency.

Proposed Solution: Helical Resonant Sequential Launcher (HRSL)
We propose a sustainable, high-efficiency electromagnetic launch system that utilizes a **Flat Helical (Spiral) Geometry** combined with **Resonant Sequential Coils**. This design redefines the acceleration path by maximizing the effective distance within a compact footprint.

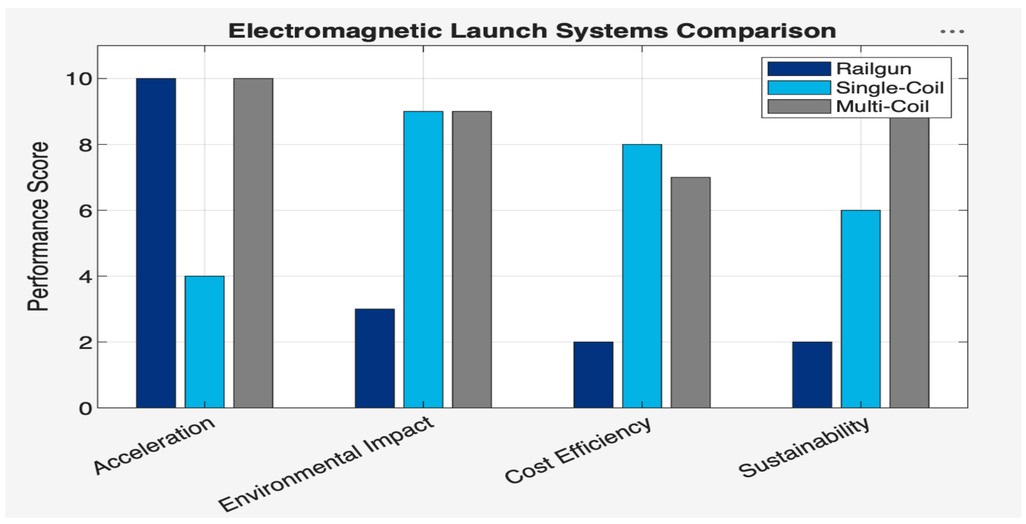
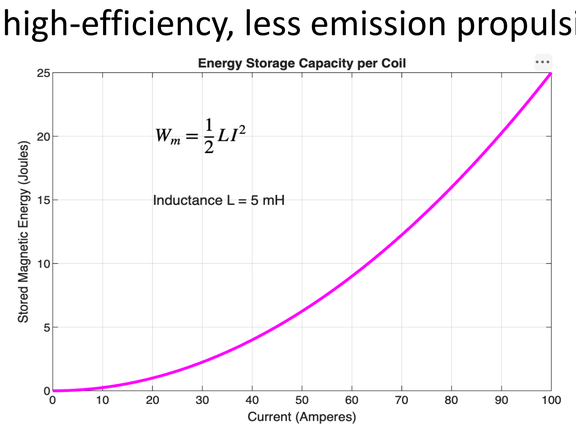


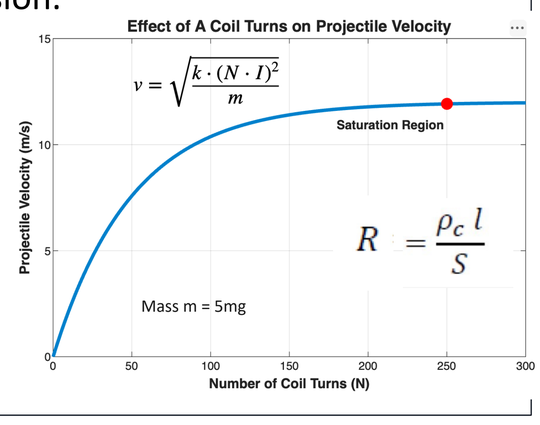
Chart 1

Results / Simulation / Discussion

1. Electromagnetic Propulsion & Energy
Data from the **Coil Turns vs. Velocity** is modeled by integrating Lorentz Force with principle of Work-Energy Theorem, which was studied in single-coil simplified in a horizontal path, this study is a baseline that essential to determine the Optimal Turn Count that each stage of the spiral accelerator is designed for maximum efficiency.
Simultaneously, the **Current vs. Stored Energy** graph verifies that resonant 20–50ms pulses deliver peak power at the exact moment of passage, maximizing efficiency and eliminating the heat waste found in conventional launchers.

2. Energy Capacity & Coil Turn Optimization
The **Projectile Velocity vs. Coil Turns** graph confirms that velocity increases with N according to the equation, as more turns intensify the magnetic flux along the 300% extended path. However, the system enters a **Saturation Region** near 250 turns, where diminishing returns occur due to increased electrical resistance and inductance. By targeting the "knee" of this curve, the HRSL maximizes energy capacity while maintaining the 20–50ms pulse timing necessary for high-efficiency, less emission propulsion.





Conclusions

The **Helical Coil Acceleration System (HCAS)** presents a transformative shift in propulsion technology, successfully bridging the gap between high-speed performance and environmental sustainability. By replacing traditional chemical propellants with a **flat helical coil architecture**, the project achieves nearly a **300% increase in acceleration distance** within a compact, cost-effective footprint.

The integration of **resonant sequential pulsing** (20–50ms) ensures that energy is utilized with maximum efficiency, eliminating the thermal waste and toxic emissions inherent in conventional systems. Ultimately, this research proves that electromagnetic sequential attraction is not only a viable technical alternative but also a superior industrial solution, offering a **less emission**, scalable, and high-precision platform for the future of high-speed transport and satellite launch applications.

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