CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

S1724

Project Title

Quantum Locking Aircraft: Towards the Development of Magnetically Assisted Landing and Take-off Systems via Flux Pinning

Abstract

Objectives/Goals

Despite the incredible amount of automated flight capability in both manned and unmanned aircraft, human oversight is still required, especially during the landing process. This project focuses on the development of a new reliable landing and take-off system for aircraft and unmanned aerial vehicles (drones) using flux pinning.

Quantum locking is the application of flux pinning to create a stable form of levitation which pins a superconductor within a strong magnetic field allowing movement only along regions of constant flux. The advantages of integrating quantum locking into the development of new landing and take-off systems for aircraft have yet to be fully explored.

Methods/Materials

This research project focused on studying the kinetics of a quantum locked superconductor as it travels through a non-uniform magnetic field. A magnetic track consisting of a series of neodymium magnets with different gap sizes was constructed to generate a varying magnetic field along the motion of the superconductor. Changes to the superconductor motion were captured using a high speed camera for later analysis.

Results

It was found that a larger magnetic field variation (larger gap sizes) resulted in a greater reduction of kinetic energy of the superconductor and that the relationship was non-linear. A t-test was used to show that there was significant difference in kinetic energy loss for each tested gap size. Furthermore, computing the correlation coefficient between the tested variables showed that this loss of energy was independent of both the mass and incoming velocity of the superconductor. A more theoretical approach was then taken in order to correlate the magnetic field profiles throughout each gap with the observed reduction of kinetic energy. It was found that loss of energy can be estimated by integrating the magnitude of the rate of change of the magnetic field throughout each gap and that this mathematical relationship matches the observed experimental results closely.

Conclusions/Discussion

Lastly, a prototype test track was constructed to test the capture and slowing of incoming aircraft. Superconductors were attached to a Styrofoam glider plane which successfully landed on the magnetic track. Furthermore, the test track was rocked from side to side to simulate conditions on an aircraft carrier and was still able to safely capture the incoming plane.

Summary Statement

I am developing a new innovative landing system for airplanes and drones that locks an aircraft equipped with cooled superconductors into a strong magnetic field and allows for controlled movement along a magnetic track.

Help Received

Friends and family provided a second set of hands during experimentation; Airgas provided me with liquid nitrogen and safety instructions; and my high school math teacher helped me with data analysis.