Mick Zaatra
Item 6

## ABSTRACT

What's being addressed is the efficiency and capabilities of our current attitude control systems and their abilities to be utilized in different orbital altitudes and scenarios. The attitude control systems that are in current use all have constraints. This is being addressed because different satellite operations require different types of Attitude Control Systems and there isn't one sole system that can address and support all different types of orbits and satellite capabilities, either due to insufficient torques, longevity, efficiencies, or environmental orbital constraints. To address these issues ferrofluid is going to be used to design a potential alternate style of attitude control that can be easily modified to support all different types of satellite missions regardless of orbital heights, power constraints, or spacecraft size.

## PURPOSE/BENEFIT

The purpose of this project is to present an insight into possible future attitude control where a modular system can be easily modified to compliment any spacecraft mission that requires attitude control with little to no limitations. Some of our attitude control systems today are quite expensive to use, and this is partly due to the fact that they require intensive testing to ensure they perform well and that they are durable and can last for the life of the intended mission. Unfortunately, most of these systems are not useable in all orbits, they are constrained on the use of the Earth's magnetic field, they aren't adjustable or modular, they require fuel which is limited in capacity, or they are just simply limited to a single directional force.

By utilizing ferrofluid in our attitude control systems many of these issues can be resolved. Ferrofluids are less prone to mechanical failures because they aren't mechanical in nature. Instead, ferrofluid systems rely on electrically induced magnetic fields that controls the

ferrofluid enclosed in a system where it's isolated from any tainting or external influence that impacts its longevity.

Ferrofluid is oil based and has very little friction compared to mechanical components and therefore efficiency is improved because less energy is lost through heat. Ferrofluid systems are also flexible, different amounts of fluids can be controlled within the systems which allows for variable mass manipulation and doesn't require any fuel whatsoever. By placing an induced magnetic field around the entirety of the system we are able to spin the fluid in any orientation giving us multi-directional torque capabilities. Unlike other systems where each component is only able to orient itself about a single axis and multiple components must then be used to ensure that all axis of rotations is accounted for. Since the proposed ferrofluid system is an isolated system it doesn't require any prerequisites just a dedicated power supply to ensure it can stay in operation. This system can therefore be used in a wide variety of orbital altitudes and increasing the size of the system and adding more ferrofluid would allow for higher torques of bigger spacecraft needs.

## Diagrams

Currently the design, as seen in Figure 1., consists of a spherical container that is able to safely hold the ferrofluid and is surrounded by inductors that will be providing the induced magnetic fields. The inductors will be turned on sequentially and at higher frequencies to spin the ferrofluid faster. The spinning mass would then create a torque thus providing us with attitude control. More inductors can be added around the container to provide rotational capabilities at any degree.

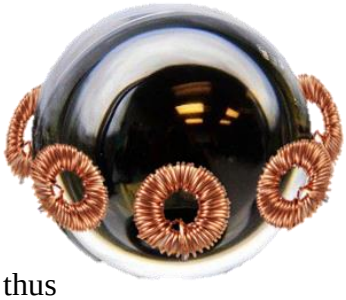

*Figure 1. Ferrofluid container surrounded by inductors.*

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## Resources

Informative resources are going to be provided through research and other experiments where ferrofluid was used. Already known knowledge of electronics, physics, and programming would also serve well in the assembly of the project. Materialistic resources are readily available and most of which are already attained. Currently only ferrofluid and inductors are the materials that we don't have yet. We have 3D printing resources available, we have software that will aide us in 3D modeling and circuit analysis setup, and we also have access to most of the wiring and electrical components that will be used to construct the circuits of the design.

## Biography

I am currently majoring in Astronautical Engineering. I have had 6 years of experience working in the automotive field as a mechanic and continued expanding in the field of automotive safety and became a certified state inspector, where I carefully inspected safety equipment of vehicles in accordance to Maryland Law. I have had experience in AutoCAD for 6 years where I took courses in "Drafting & Annotation" and "Advanced Engineer Drawings", while also participating in the FRC competition as a Team Driver and a Robotics Engineer. I also currently hold 2 certifications from MIT in Electrical Engineering and in Kinematics & Dynamics.