

# CUBITRON

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## INTRODUCTION

In this project, we aim to design and build a self-balancing cube using reaction wheels, a type of control mechanism commonly used in spacecraft for attitude control. The goal is to create a compact, dynamically stable system capable of maintaining its equilibrium in three-dimensional space without external support. The cube, with its simple geometric structure, presents unique challenges in terms of balance and orientation control, making it an excellent platform for exploring the principles of feedback control systems and mechanical design.

Reaction wheels, which function by spinning at varying speeds to produce torques that counteract disturbances, will serve as the core actuators for balancing the cube. By carefully coordinating the speeds of these wheels, the system will be able to counteract any rotational forces, allowing the cube to maintain stability in any orientation.

This project will involve multiple stages, including the design and fabrication of the cube, the selection and integration of reaction wheels, the development of sensors to track its orientation, and the implementation of a control algorithm that adjusts the wheel speeds in real-time to correct any deviations. The project not only challenges our understanding of dynamic systems and control theory but also has the potential to inform future applications in robotics, aerospace, and precision engineering, where balance and stability are crucial.

Ultimately, the self-balancing cube will serve as a proof-of-concept for demonstrating the potential of reaction wheels in balancing and controlling small-scale systems, offering a hands-on opportunity to delve into the fascinating intersection of mechanical engineering, robotics, and control theory.

## FIRST PRINCIPLES

How can we balance with just a set of spinning wheels that don't even touch the ground? Well the same way you and I would balance on a slack line or on a fence post, We pivot our arms around our torso kinda like how a plane would turn its wings when banking. How this makes us balance is not at all obvious, but it has something to do with angular momentum and torques, considering that we are rotating our body. Another hint is that by extending our arms further out or even using a rod to artificially extend our arms we can greatly enhance our ability to balance. By doing so we create torque, we can use this exact technique with flywheels only instead of it being two arms we essentially have infinite arms stacked in a circle.