

Cost-Effective CubeSat with Micro-Thrusters

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INTRODUCTION & BACKGROUND

A 3U CubeSat is a small satellite measuring 10×10×30 cm, made by stacking three standard 1U units. Originally developed for educational purposes, CubeSats are now widely used for scientific research, technology testing, and commercial missions. Their compact size, low cost, and standardized design make them ideal for rapid deployment in space.

PROBLEM STATEMENT

Designing and constructing a cost- and power-efficient 3U CubeSat, integrating key subsystems such as communication, ADCS, power, and structure, with a specific focus on developing gas micro-thrusters for precise attitude control.

3U CUBESAT FEATURES

- Reliable locally made Attitude Determination and Control System, using cold gas micro-thrusters .
- Uses environmentally friendly nitrogen gas to control its stability.
- Minimizes power consumption.
- Withstand launching vehicle vibrations.
- Reliable radio wave communication system.
- Withstand temperature fluctuations.
- Reliable power generation system, using solar panels.

CONSTRAINTS

Constraints	Project specific	Constraints	Project specific
Structure can withstand vibration value of 20 Hz to 1000 Hz	✓	Withstand temperature fluctuations - 65°C to 100°C	✓
Volume of CubeSat 10X10X34.05 cm	✓	Center of mass within 2cm of the geometric center	✓
Providing 5V and 3.3V to the subsystems	✓	GNSS positioning error < 5 m	✓

SPECIFICATIONS

Specifications	Project Specific
CubeSat weight is less than 6KG	✓
Achieve detumbling within 5 minutes	✓
Reorienting the CubeSat within 10 seconds	✓

PROTOTYPE DESIGN



Concept Design

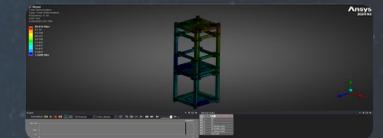


CAD Design (3D)

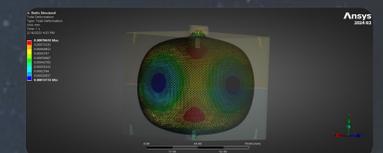


Final Product

TESTING & VALIDATION



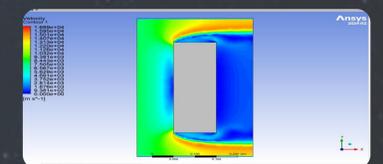
The launching vehicle's vibration can vary from 20–1000 Hz depending on the vehicle, resulting in frequency ratios of 0.0524 (lowest) and 2.620 (highest).



CubeSat gas tank and analyzing its internal pressure, structural testing confirmed that the T6-7075 aluminum can withstand up to 50 bars, a common space-grade pressure.



Simulated orbit of a 3U CubeSat in Low Earth Orbit (LEO) as part of a link budget analysis on 180 km altitude.



Aerodynamic drag analyses for The 3U CubeSats operating at altitudes around 180 km

CONCLUSION

By minimizing power consumption and developing a locally engineered ADCS system, this project presents a cost-effective and sustainable solution for CubeSat missions. These advancements can significantly extend satellite lifespan and reduce operational costs—offering valuable opportunities for companies, particularly in Saudi Arabia, to adopt and benefit from domestically developed space technologies.