Exploring CubeSats and CanSats: A Mini Research

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***Abstract*—CubeSats and CanSats have provided broader access to satellites and space by opening up research and development to students, universities, and private organizations that were previously the preserve of the big space agencies. This study examines their design, developmental history, working procedures, scientific contributions, educational roles, and future advancements, as well as providing information on successful missions and applications.**

I. Introduction

The advancement of miniaturized satellite technologies has transformed access to space. CubeSats and CanSats are two such platforms that offer significant educational and research opportunities. Originating from academic initiatives, they have now expanded into industry and interplanetary missions.

II. CubeSats: Micro-Satellites with Macro Impact

A. Definition and Form Factor

CubeSats are a class of nanosatellites built in standardized units of 10 cm $\times$ 10 cm $\times$ 10 cm (1U) and typically weigh up to 1.33 kg per unit. Configurations like 1U, 2U, 3U, 6U, and 12U allow modular scalability. These dimensions are ideal for standardized launch mechanisms like the Poly Picosatellite Orbital Deployer (P-POD) [1].

B. Historical Background

The CubeSat initiative began in 1999 as a collaborative project between California Polytechnic State University and Stanford University. The objective was to provide hands-on satellite design experience for students at a fraction of traditional costs [2]. Since then, more than 1600 CubeSats have been launched, serving diverse scientific, technological, and commercial roles.

C. Subsystem Architecture

CubeSats typically comprise the following subsystems:

- **Structure**: Lightweight aluminum frames with PCB-based internal mountings.
- **Power**: Solar panels and Lithium-ion batteries; includes power distribution units (PDU).
- **Onboard Computer (OBC)**: Controls data acquisition, telemetry, and attitude algorithms.
- **Communication**: UHF/VHF, S-band, or X-band transceivers for ground communication.
- **Attitude Determination and Control System (ADCS)**: Includes gyros, magnetometers, sun sensors, and reaction wheels.

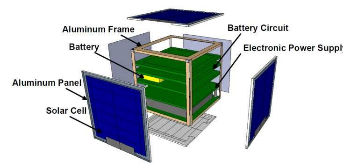

Fig. 1. Standard 1 U CubeSat diagram [8]

- **Payload**: Custom sensors, cameras, or scientific instruments.

D. Applications

CubeSats are used in:

- **Earth Observation** (e.g., Planet Labs' Dove constellation)
- **Deep Space Exploration** (e.g., NASA's MarCO mission)
- **Atmospheric Research**
- **Communication Technology Demos**
- **Biological and Materials Science Experiments**

E. Notable Missions

- **MarCO-A/B (2018)**: Relayed InSight landing data from Mars, proving CubeSats can operate in deep space [3].
- **Lunar IceCube**: Launched aboard Artemis I to search for lunar water ice [4].
- **ASTERIA**: CubeSat from Jet Propulsion Lab for exoplanet transit detection.

III. CanSats: Simulated Satellites in a Can

A. Definition and Dimensions

A CanSat is a simulation of a satellite housed within the volume of a 330 ml soft drink can. Typical CanSat dimensions are 66 mm in diameter and 115 mm in height, weighing less than 350 grams. They are launched using model rockets or high-altitude balloons up to altitudes of 1 km.

B. Structure and Operation

CanSats include:

- Microcontroller (e.g., Arduino, Raspberry Pi)
- Environmental sensors (temperature, pressure, humidity, GPS)
- Telemetry module (e.g., XBee, LoRa)
- Power source (Li-Po battery)
- Recovery system (parachute or rotor-based)

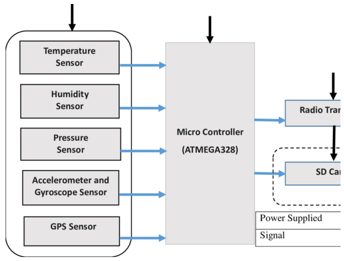

Fig. 2. Block Diagram of CanSat [7]

C. Typical Mission Phases

1) **Launch**: Rocket carries CanSat to 1 km.
2) **Deployment**: CanSat is ejected mid-air.
3) **Descent and Data Collection**: Sensors operate while descending slowly.
4) **Recovery and Analysis**: Students retrieve data post-mission.

D. Educational and Competitive Value

CanSats are used in:

- School and university engineering curricula
- National and international competitions (e.g., ESA CanSat, ARLISS in the US)
- Introduction to aerospace systems engineering

IV. Comparative Overview

TABLE I
COMPARISON BETWEEN CUBESATS AND CANSATS

Feature	**CubeSat**	**CanSat**
Size	Modular cubes of 1U (10 cm)	Soda-can sized
Launch	Low Earth Orbit (LEO)	Sub-orbital (1 km)
Cost	\$50,000–\$1 million	\$300–\$1,000
Mission Duration	Months to years	Minutes
Applications	Research, comms, tech demo	Education, rapid prototyping
Design Complexity	High	Moderate

V. Recent Trends and Innovations

- **Swarm Constellations**: Companies like Swarm and Planet Labs deploy large numbers of CubeSats for data coverage.
- **Propulsion Systems**: Electric propulsion systems (ion thrusters, cold gas) are being miniaturized for CubeSats.
- **Interplanetary Prospects**: CubeSats are now mission components in Artemis and Mars missions.
- **AI and Edge Computing**: OBCs with machine learning capabilities onboard enable autonomous decision-making.

VI. Conclusion

CubeSats and CanSats are redefining who can participate in space exploration. While CubeSats provide compact but powerful tools for conducting orbital science and communication, CanSats serve as excellent educational platforms for understanding the full lifecycle of a space mission. Together, they form the building blocks of a more democratized, innovative, and accessible future in aerospace.

References

[1] J. Puig-Suari, C. Turner, and W. Ahlgren, “Development of the standard CubeSat deployer and a CubeSat class PicoSatellite,” in *IEEE Aerospace Conf.*, 2001. https://ieeexplore.ieee.org/document/931726

[2] Wikipedia contributors, “CubeSat,” *Wikipedia, The Free Encyclopedia*, Available: https://en.wikipedia.org/wiki/CubeSat

[3] Wikipedia contributors, “Mars Cube One,” *Wikipedia*, Available: https://en.wikipedia.org/wiki/Mars_Cube_One

[4] NASA, “Lunar IceCube,” NASA Missions, Available: https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=2022-156C

[5] Wikipedia contributors, “CanSat,” *Wikipedia*, Available: https://en.wikipedia.org/wiki/CanSat

[6] European Space Agency, “ESA CanSat Program,” Available: https://www.esa.int/Education/CanSat

[7] Paudel, Saurav and Shrestha, Safal and Thapa, Jiten and Shrestha, Shulab. (2017). Atmospheric Data Measurement using Can-Sat and Data Logging in Ground Station. 10.13140/RG.2.2.20410.29125. “Block Diagram of CanSat,” Available: https://www.researchgate.net/publication/326505110_Atmospheric_Data_Measurement_using_Can-Sat_and_Data_Logging_in_Ground_Station

[8] Darbali-Zamora, Rachid Merced, Daniel Gonzalez-Ortiz, Cesar Ortiz-Rivera, Eduardo. (2014). An Electric Power Supply design for the space plasma ionic charge analyzer (SPICA) CubeSat. 1790-1795. 10.1109/PVSC.2014.6925270. “Standard 1 U CubeSat diagram,” Available: https://www.researchgate.net/publication/290100326_An_Electric_Power_Supply_design_for_the_space_plasma_ionic_charge_analyzer_SPICA_CubeSat