



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 15, Issue 3, March 2026

CubeSat: A Miniaturized Satellite

Mr. Shaikh A.A¹, Mr. Naikude R.N², Mr. Parchande S.V³, Mr. Dhumal S.J⁴, Mr. Gaikwad A.J⁵,

Rajesh Ratnakar Khiste⁶

Department of Electronics & Telecommunication, Karmayogi Institute of Technology, Maharashtra, India

ABSTRACT: CubeSat is a miniaturized satellite designed for space research and educational purposes. It follows a standardized cube-shaped structure typically measuring $10 \times 10 \times 10$ cm, which makes it compact, lightweight, and cost-effective compared to traditional satellites. CubeSats are widely used by universities, research organizations, and space agencies for scientific experiments, Earth observation, technology demonstrations, and communication testing.

This project demonstrates a CubeSat communication system using modern embedded electronics. The satellite unit uses sensors and a microcontroller to collect orientation and telemetry data. The data is processed and transmitted wirelessly to a ground-based receiver station using radio communication modules. The ground station receives the transmitted information, displays the satellite orientation, and allows basic monitoring of the system.

The system simulates important satellite operations such as telemetry transmission, wireless communication, and attitude monitoring. This project provides a practical understanding of CubeSat technology and demonstrates how small satellite communication systems can be developed using low-cost electronic components.

KEYWORDS: CubeSat, Satellite Communication, ESP32, NRF24L01, IMU Sensor, Telemetry, Ground Station.

ACKNOWLEDGMENT: It is with profound sense of gratitude that I acknowledge the constant help and encouragement from our Project guide & Mentor Prof. Mr. Khiste R.R., Head of Electronics & Telecommunication engineering department Prof. Mr. Khiste R.R., hon. Principal Dr. Kanase A.B. and whole hearted thanks to my family. This is to acknowledge and thanks to all individuals who played defining role in creating this work.

I. INTRODUCTION

CubeSats are a class of small satellites designed using a standardized modular structure. A single CubeSat unit (1U) measures $10 \times 10 \times 10$ cm, and multiple units can be combined to form larger satellites such as 2U or 3U. Due to their compact size, lower development cost, and shorter development cycle, CubeSats have become popular for research, educational missions, and technology demonstrations.

Communication is a key subsystem in a CubeSat mission. It enables the satellite to transmit telemetry data to the ground station and receive control commands from operators on Earth. The communication system generally includes a radio transceiver, antenna, onboard processing unit, and a ground station receiver.

The onboard system gathers information from various sensors and processes it before transmitting the data through a wireless communication link. The ground station receives the transmitted signals, decodes the data, and displays it for monitoring and analysis.

Because CubeSats have limited size, power, and weight capacity, their communication systems must be efficient, reliable, and optimized for low power consumption. A well-designed communication system ensures continuous data exchange and supports the successful operation of the CubeSat mission.

Volume 15, Issue 3, March 2026**|DOI: 10.15680/IJRSET.2026.1503133|**

II. EXISTING SYSTEM

Traditional satellite systems used for communication and observation are large, complex, and expensive. These satellites are typically developed by national space agencies and require high-cost launch vehicles and sophisticated infrastructure.

Modern small satellite missions use CubeSat technology to reduce development cost and simplify the design process. However, many communication systems used in satellites are still complex and difficult to implement in educational environments.

Limitations

- High development and launch cost
- Complex communication infrastructure
- Large satellite size and weight
- Limited accessibility for educational institutions

III. PROPOSED SYSTEM

The proposed system is a CubeSat prototype designed to simulate satellite communication between a satellite unit and a ground station.

The satellite unit includes an ESP32 microcontroller that collects data from sensors such as the GY-91 IMU module and a magnetometer to measure orientation and environmental parameters. The collected data is processed and transmitted wirelessly using the NRF24L01 communication module.

The ground station includes another ESP32 microcontroller connected to multiple OLED displays through a TCA9548A I2C multiplexer. The received data is displayed in real time, allowing monitoring of satellite orientation and system status.

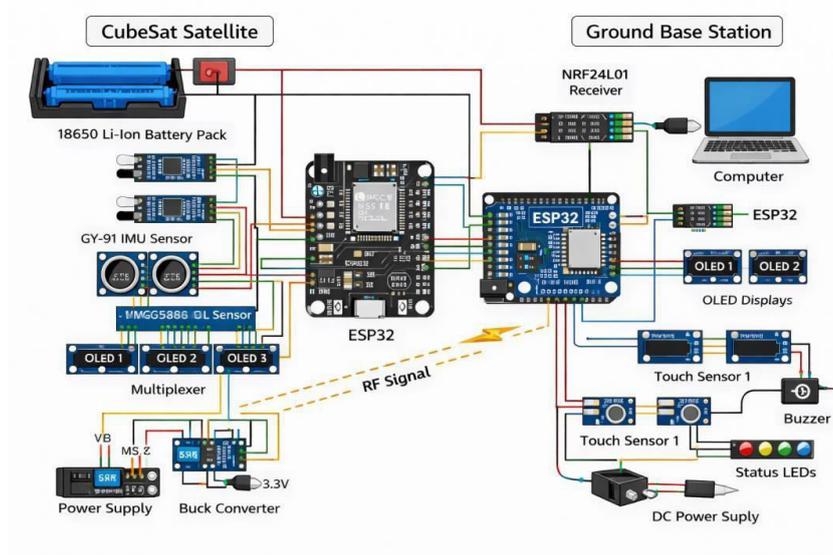
IV. LITERATURE REVIEW

Several researchers have studied the design and improvement of communication systems used in CubeSat missions. CubeSat communication mainly focuses on reliable data transmission, low power consumption, and efficient use of limited onboard resources.

The communication subsystem generally includes telemetry and telecommand modules. The telemetry system transmits satellite data such as sensor readings and system status to the ground station, while the telecommand system allows the ground station to send control instructions back to the satellite.

Many studies also discuss different transceiver designs, communication protocols, and antenna systems used in CubeSats. Researchers aim to improve communication reliability, data rate, and signal coverage while keeping the system compact and energy efficient.

V. SYSTEM ARCHITECTURE & BLOCK DIAGRAM



VI. OBJECTIVES

- To design and develop a CubeSat prototype for educational and research purposes.
- To implement wireless communication between the CubeSat and ground station.
- To measure satellite orientation using sensors such as IMU and magnetometer.
- To transmit telemetry data from the satellite to the ground station in real time.
- To display satellite orientation and system status on the ground station interface.
- To develop a cost-effective CubeSat communication system using embedded electronics.

VII. RESULTS AND IMPLEMENTATION

The developed CubeSat prototype successfully demonstrates wireless communication between the satellite unit and the ground station. The satellite system collects sensor data such as orientation, motion, and environmental parameters using the GY-91 IMU module and magnetometer.

The ESP32 microcontroller processes the sensor data and transmits it wirelessly using the NRF24L01 communication module. The ground station receives the transmitted information and displays the satellite orientation and telemetry data on OLED displays.

The results demonstrate that:

- The sensor module accurately measures orientation and motion data.
- The NRF24L01 communication module provides reliable wireless data transmission.
- The ground station successfully receives and displays real-time satellite data.
- The system effectively simulates satellite telemetry communication.

This implementation confirms that CubeSat communication systems can be developed using low-cost embedded hardware for educational and experimental purposes.

VIII. CONCLUSION AND FUTURE SCOPE

The CubeSat communication system provides a compact and cost-effective platform for understanding satellite communication and telemetry systems. The developed prototype demonstrates how sensor data can be collected, processed, and transmitted wirelessly to a ground station.

The system successfully simulates key satellite operations such as telemetry transmission, orientation monitoring, and ground station communication. This project helps students and researchers gain practical knowledge of CubeSat technology and satellite communication systems.

Future Scope

- Integration of GPS modules for satellite position tracking.
- Implementation of advanced attitude control systems.
- Use of higher-range RF communication modules.
- Integration of camera modules for Earth observation experiments.
- Development of a fully functional CubeSat system for real satellite missions.

REFERENCES

1. J. R. Puig-Suari and B. Twiggs, "Design Specification for CubeSat Standard," Aerospace Engineering Journal.
2. IEEE Research Papers on CubeSat Communication Systems.
3. NASA CubeSat Design Specification Documents.
4. Journal of Spacecraft and Rockets – CubeSat Technologies.
5. Research articles on small satellite communication and telemetry systems.

BIOGRAPHY

1. Mr. **Shaikh Ayan Alim**, Currently Studying in Karmayogi Institute of Technology, Shelve Pandharpur.



Mr. **Naikude Ruturaj Navnath**, Currently Studying in Karmayogi Institute of Technology, Shelve Pandharpur



Mr. **Dhumal Shubham Jalinder**, Currently Studying in Karmayogi Institute of Technology, Shelve Pandharpur.



Mr. **Parchande Shrinivas Vithal**, Currently Studying in Karmayogi Institute of Technology, Shelve Pandharpur.

Volume 15, Issue 3, March 2026

|DOI: 10.15680/IJIRSET.2026.1503133|



Mr. **Gaikwad Aryan Jaisingh**, Currently Studying in Karmayogi Institute of Technology, Shelve Pandharpur.



Mr Rajesh Ratnakar Khiste is currently working as Lecturer in Karmayogi Institute of Technology Shelve-Pandharpur. He pursued his Bachelor of Engineering degree M.E. (Electronics & Tele- communication) from T.K.I.E.T. Warananagar. Dist. Kolhapur, Maharashtra, India -413304.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details