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Performance Evaluation of Wireless Communication for Aerial Radiation Detection Using a Multi-Channel Detector Mounted on a Drone

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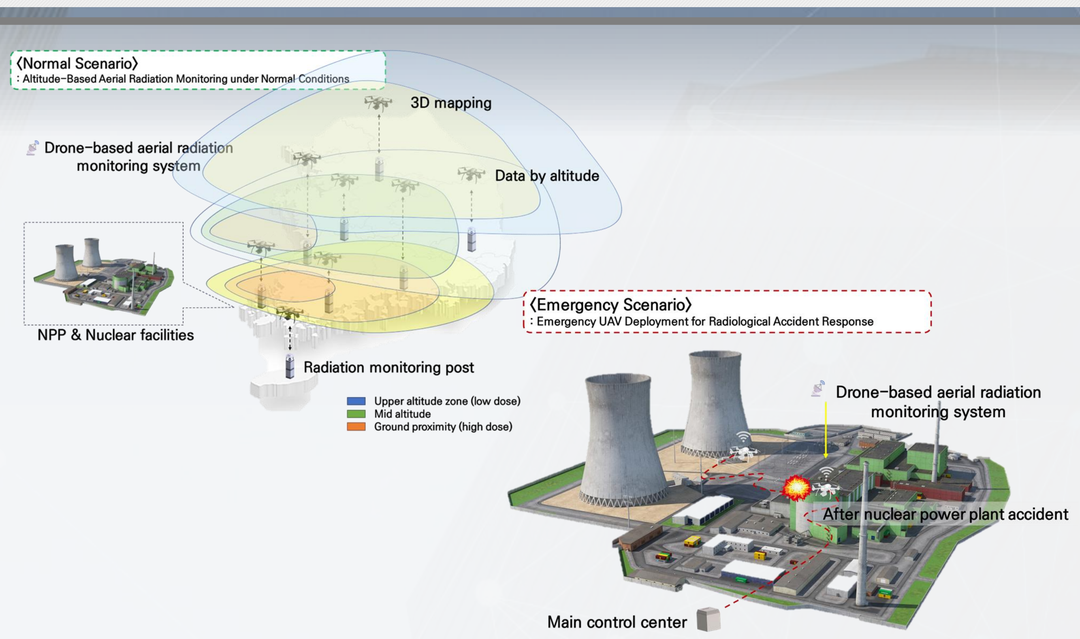
Background & Objectives

- **Challenge**
  - Rapid response to nuclear accidents demands early-stage, altitude-based radiation monitoring.
  - Ground systems are limited in accessing wide or vertical radiation profiles.
- **Why UAVs?**
  - Drones offer high mobility and access to hazardous or unreachable zones.
  - Ideal for real-time, altitude-resolved radiation assessment.
- **Limitations of Conventional Systems**
  - Mostly single-channel detectors
  - Manual spectrum interpretation
  - Insufficient for fast-response, multi-source environments
- **This Study Proposes**
  - Development of a drone-mounted, multi-channel radiation detection system using compact CZT spectrometers
  - Integration of GPS for precise localization
  - Evaluation of wireless communication (USB, LTE, Zigbee) for real-time data transfer
- **Objective**
  - Identify the most reliable communication method for UAV-based radiation monitoring
  - Enhance accuracy, resolution, and operational readiness in emergency scenarios

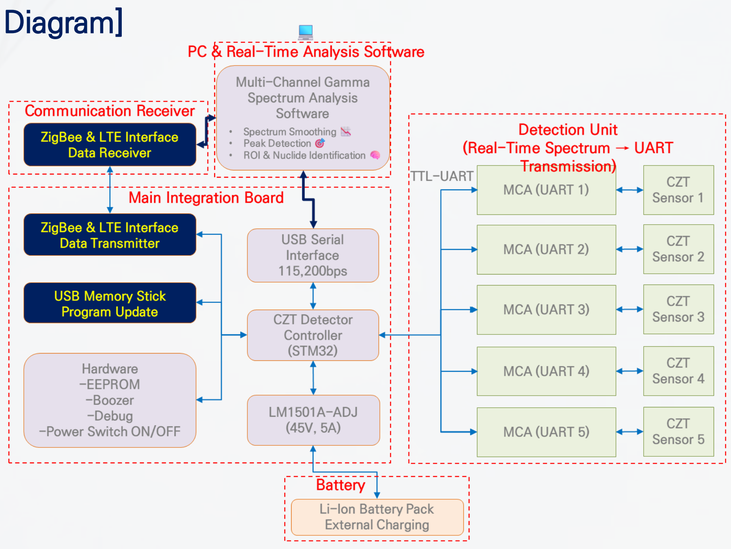


Experimental Setup and Results

[Detection System Components]

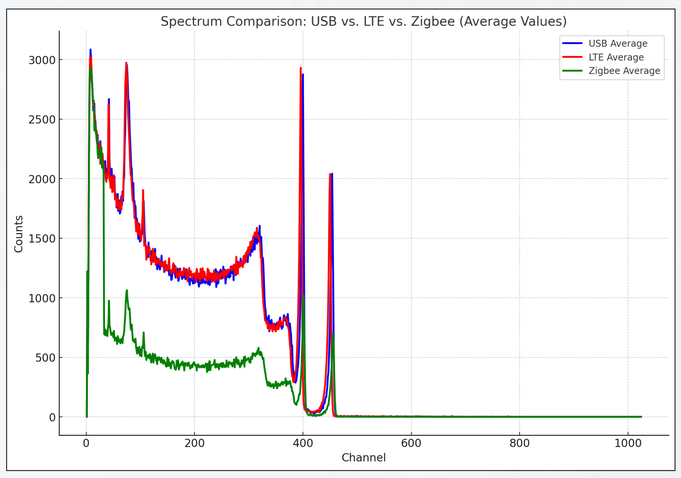
Component	Description
Multi-Channel Radiation Detector	Semiconductor-type CZT detectors (4 units) coupled with a compact MCA for simultaneous multi-point gamma detection and radionuclide identification. - Volume: 500 mm^3 - Resolution: FWHM 9.9±0.5 keV @ 662 keV - Room-temperature operation, small form factor
Drone Platform	Stable UAV platform with sufficient payload capacity to carry detection system. Equipped with GPS module and wireless modules for real-time transmission.
Wireless Communication Module	USB (wired), LTE, and Zigbee interfaces tested for transmission quality at ~10 m. LTE demonstrated the highest stability over distance with minimal data loss.

[System Block Diagram]

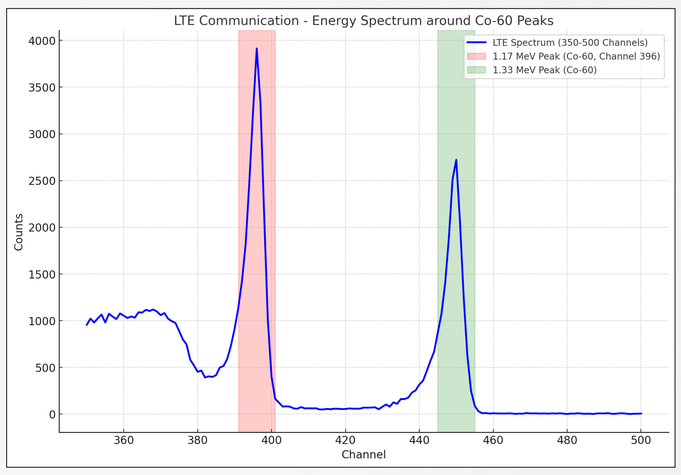


System Configuration for UAV-based Aerial Radiation Monitoring

[Experimental Results (Co-60 isotope test)]



Comparison of Energy Spectra Using USB, Zigbee, and LTE Communication Methods



Measured energy spectrum of Co-60 peaks for LTE communication method

📌 LTE communication ensures high-fidelity gamma spectrum transmission with minimal data loss, making it the most reliable method for drone-based radiation monitoring.

Conclusions & Future Works

- Developed a drone-based, multi-channel radiation detection system for altitude-resolved airborne monitoring.
- Integrated USB, LTE, Zigbee communication modules for real-time data transmission evaluation.
- All methods were stable at short distances.
- LTE consistently outperformed Zigbee over extended ranges, maintaining 〉95% data integrity.
- Zigbee exhibited 〉20% data loss at 10 m, limiting its use in field conditions.

Future Works

- Optimize communication protocols for latency and robustness
- Minimize data loss under dynamic UAV operation
- Extend system integration for real-time emergency response and autonomous flight operations

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