A WiFi-based Radiation Emulation System Designed for Testing Intelligent Radiation Surveying Methods

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Introduction and Motivation

- An intelligent mapping algorithm (HazNav) is being developed to accelerate radiological survey and lost source localization.
- Experimental testing requires radioactive sources and personnel exposure, and is especially difficult to scale.
- Radiation point sources decrease in intensity proportional to one over distance squared.
- WiFi receivers and emitters thus emulate ionizing radiation detectors and sources.

Mission Relevance

- Testing monitoring and response instruments and methods at scale
- Practical dose-free training for inspectors and radiation protection professionals;
- Public, K-12, and college outreach.

Expected Impact

- Safer, more easily scaled, and accessible tool for testing survey methods
- Radiation detection emulation for training and outreach activities
- Possible new, affordable positioning sensor

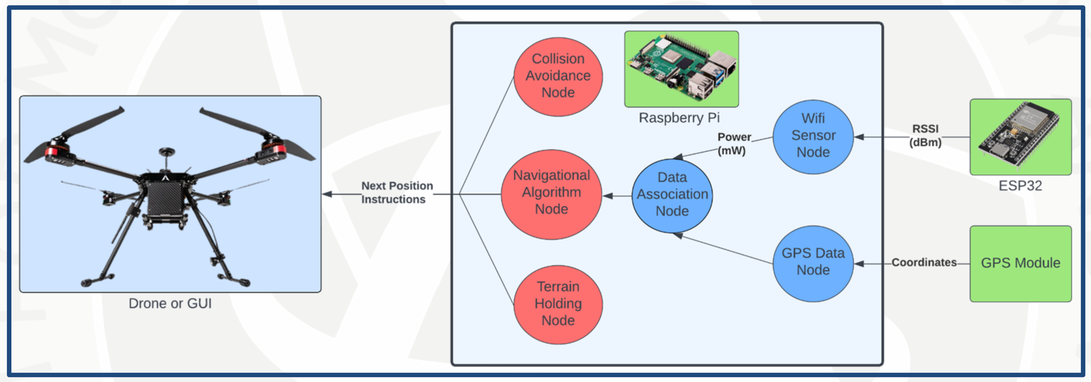
MTV Impact

Undergraduate Research Presentations

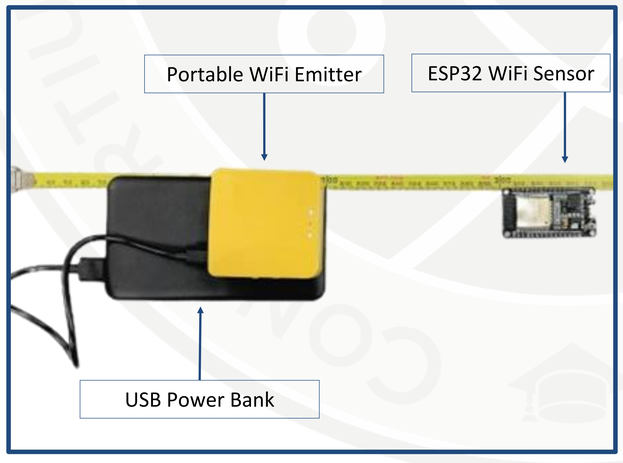
- UPR: 1(6/23), 1(6/22)
- U-M INEL Visit 1(5/23)
- U-M UROP: 4(4/23), 1(4/22)
- MTV Workshop: 4(3/23), 2(3/22)
- Health Physics Society: 3(7/22)
- Great Lakes HPS: 1(4/22)
- International Radiation Protection Association: 5(7/24)

Technical Approach

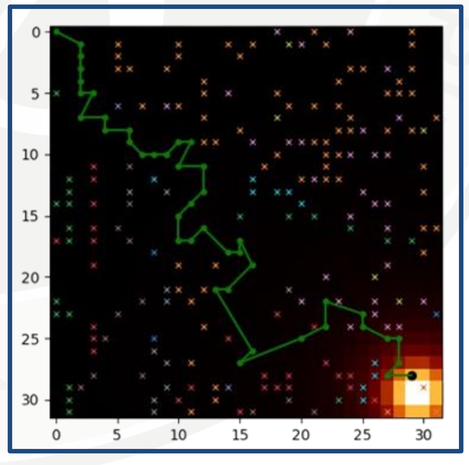
- Low cost ESP32 Microcontroller performs Received Signal Strength Indicator (RSSI) measurements for a specified network, then communicates with Raspberry Pi Microcomputer via I2C
- Robot Operating System 2 (ROS2) software on the Raspberry Pi organizes programs into nodes which interact to process then send data to the navigational algorithm
- Navigation algorithm outputs GPS coordinates for next sampling site



▲ROS2 node and subnode interactions and dataflow



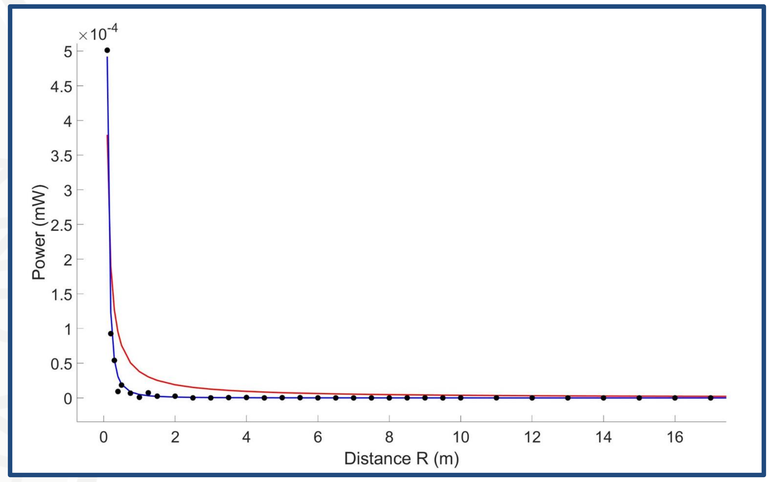
▲Experimental setup for WiFi measurements over fixed distances



▲Potential application: Test Bayesian estimation algorithm navigation to source (shown in simulation)

Results and Conclusions

- Development of sensor node and integration with Raspberry Pi completed and ready for implementation with other nodes
- Initial experimental testing of system completed, successfully modeling inverse squared behavior



▲Measured WiFi signal (black points) as a function of distance, R, from emitter with best fits to 1/R (red line) and $1/R^2$ (blue line)

Next Steps

- Integration with autonomous drone platforms and survey instruments
- Development of graphical user interface for manual survey
- Additional experimental testing and evaluation including execution with navigation algorithm

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