A WiFi-Sensing Payload for an Intelligent Radiation Awareness Drone (iRAD)

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Abstract

An Intelligent Radiation Awareness Drone (iRAD) is being developed which utilizes a unique algorithm (HazNav) that creates maps of ionizing radiation sources producing measurable fields. Ultimately, this source mapping software will optimize flight paths for maximal data collection efficiency. Both WiFi signals and gamma rays experience an intensity decrease that is inversely proportional to the square of the distance from their source, the primary algorithmic assumption. A WiFi-sensing payload would allow iRAD to be tested to scale without creating undue ionizing radiation hazards. WiFi intensity maps would themselves be useful for identifying weaknesses in coverage. In addition, a drone-mounted WiFi-sensing payload could locate the origins of any signal interference. Communication has been established between a WiFi sensor (Espressif Systems ESP32) and an inexpensive single-board computer, a Raspberry Pi 4B. The sensor module is a microcontroller unit with integrated WiFi and Bluetooth connectivity. The Raspberry Pi 4B is a fourth generation credit-card-sized single board computer with wireless Local Area Network. The WiFi-sensing software is roughly 85 C++ lines and performs a continuous WiFi scan that prints nearby network names and Received Signal Strength Indicator. The next step is to ensure the output of the program is compatible with HazNav. The HazNav software, which will take in signal strength data points and create a map including the individual's location and signal strength values, is being developed separately. This could be implemented on the Raspberry Pi, the flight computer, or a remote system. The WiFi-sensing payload, having a <1 kg target weight, will require weatherproofing for robustness. One potential weather-proofing method is a snuggly-fitting 3D printed case. The payload will be tested experimentally using multiple emitters before flight deployment. The resulting WiFi-sensing payload and mapping software may prove useful for both an affordable homemade drone and a commercially available heavy-lift drone.

Figure 1: iRAD Lite

Introduction

- WiFi signals and gamma rays both experience an intensity decrease that is inversely proportional to the square of the distance from their source
- Radiation search and mapping approaches (HazNav) need to be tested
- WiFi simulates radiation, thus WiFi sensing can be used to test HazNav
- Integration of WiFi sensor into payload is useful for research, training, and education purposes

Methods

Components

Arduino IDE
- Coding studio
- Serial monitor

Search/Mapping System
- Raspberry Pi 4B
- C++ or Python
- Interface to Pixhawk

Sensor
- Espressif Systems ESP32 MCU
- C++ programmable
- Integrated continuous WiFi scan

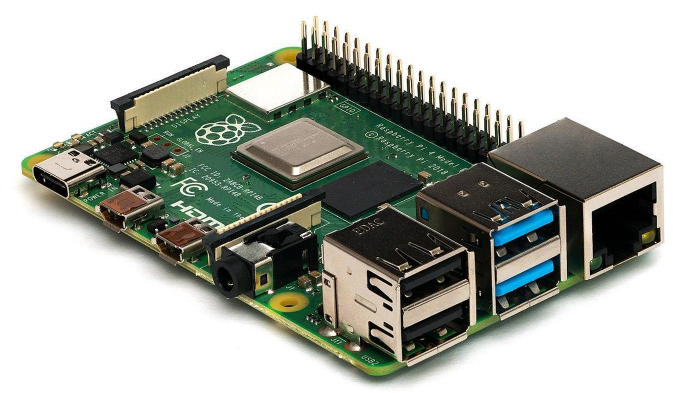

Figure 2: Raspberry Pi 4B microcomputer

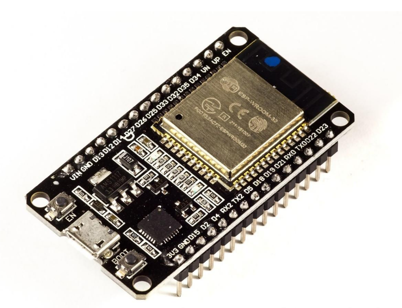

Figure 3: ESP32 microcontroller unit

Steps

- ESP32 connected to computer through micro USB
- Proper serial port software downloaded to computer to establish communication between Arduino IDE and ESP32
- Roughly 85 lines of C++ code written to perform the continuous WiFi scan
- Code uploaded to ESP32
- Continuous WiFi scan performed, cellphone hotspots utilized to determine efficacy and efficiency of scan
- Established communication between ESP32 and Raspberry Pi

Results

- ESP32 successfully scanned nearby WiFi networks
- Nearby networks names and received signal strength indicator (in decibel milliwatts) printed to the serial monitor
- ESP32 and Raspberry Pi 4B communicated effectively

Conclusion

- WiFi-sensing is a low cost and effective way to test radiation search and mapping approaches such as HazNav; approaches can be tested without causing ionizing radiation hazard
- ESP32 and Raspberry Pi 4B pairing is compatible with a modular payload

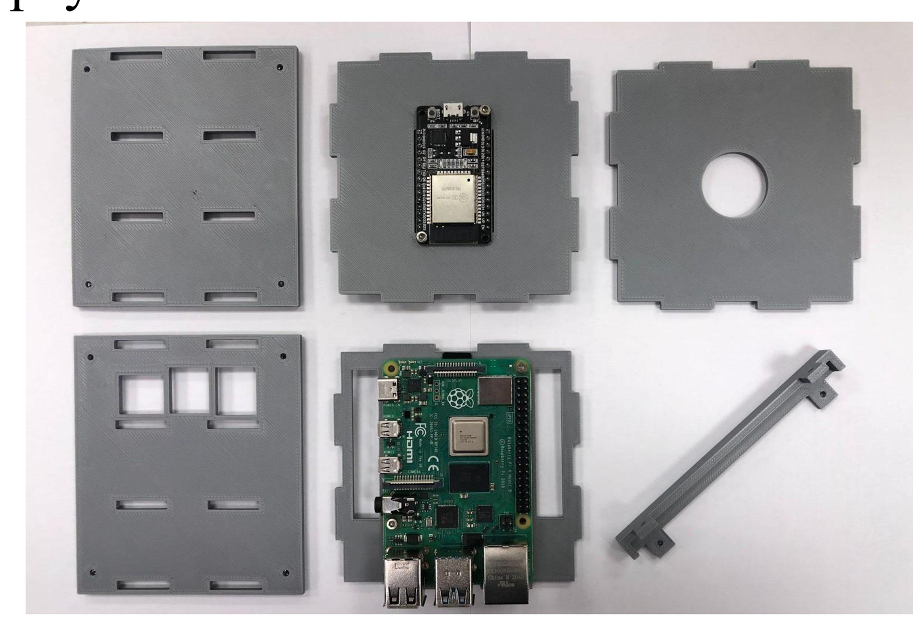

Figure 4: Raspberry Pi and ESP32 placed on the iRAD's disassembled modular payload

Future Work

- Test WiFi-sensing payload with purchased WiFi emitters
- Weatherproof the payload
- Integrate payload onto iRAD and test outdoors with WiFi emitters
- Ensure output compatible with algorithms & navigation so that HazNav can be tested

Acknowledgements

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