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Acoustic Detection of UAS With Edge Analytics

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ACOUSTIC DETECTION OF UAS WITH EDGE ANALYTICS

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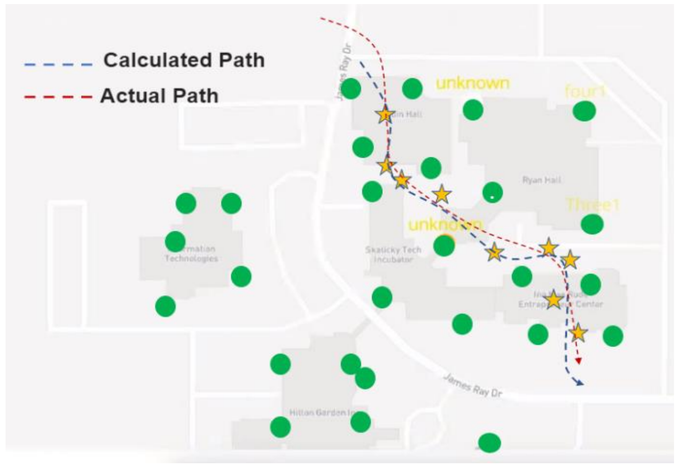
Introduction

- UAS prevalence demands robust detection.
- Counter UAS (C-UAS) defends against malicious UAS use.
- Defense requires UAS detection, identifying, and tracking.
- Focus here is on Acoustic detection for UAS tracking.
- Combine acoustic with vision and signal detection for comprehensive system for improved detection
- Edge analytics enhance C-UAS scalability and deployment.
- ML models use UAS audio data for acoustic signature detection.

Approach

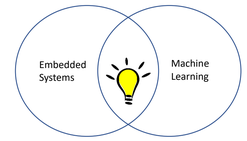
- Preliminary acoustic C-UAS system uses Arduino Nano as edge device.
- Nano operates Tiny ML for UAS acoustic signature detection.
- Ad-Hoc connectivity and Gateway for central coordination
- Nano employs wireless Low Energy for gateway device connection.
- ML results transmitted via wirelessly to gateway.
- Data forwarded from gateway to cloud for post-processing.
- Triangulation and calculation of trajectory
- Future position prediction



Shows a demonstration of user- interface of sensor deployment

Edge Analytics

Cloud	Edge
• Computation (high) • Suitable for delay tolerant and computationally intensive application • Complicated deployment planning • Centralized server, Large in size	• Computation (low) • Low latency application, real time operation and high QoS • Ad-hoc deployment with minimal planning • Low processing capability, multiple nodes



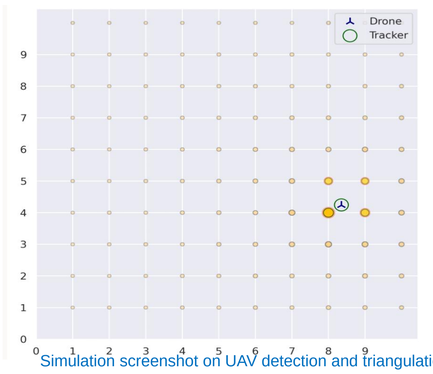
- Wireless networks for IoT / Sensor networks
- Suitable network protocol/architecture to handle massive data
- Distributed network with multiple sensors connected
- Live application data processing
- Low latency application
- Communication efficient
- Security and data Privacy
- Energy efficient devices
- Distributed Computing
- Improving local decision can help in improving system performance

Limitation

- Young field
- Hardware platform dependent
- Ad-hoc decision making still need developments
- Number of process running is limited

Simulation

- Simulation – Ad-hoc sensor deployment
- Data Capture and triangulation
- Weight factor to improve the detection Accuracy
- Real deployment may face challenges due to communication latency.



Simulation screenshot on UAV detection and triangulation

Implementation and Results

- Multiple test-bed to demonstrate the detection accuracy
- Based on 10 min dataset, achieved a detection accuracy of 72%
- Established an Bluetooth Ad-hoc connectivity
- Used directional mic to improve the detection
- Developed a web-based platform for data collection, triangulation and Visualization

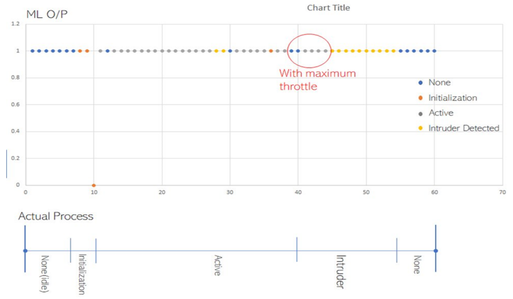
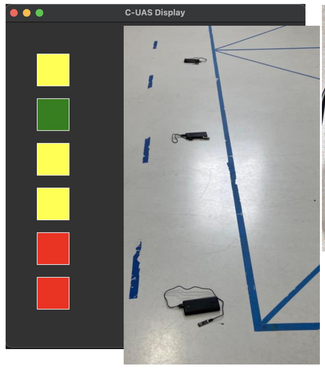


Fig shows the detection accuracy of a single Edge node detecting different data classes



Sensor deployment and the Gateway GUI

Top: A Arduino nano BLE node powered with a power bank. **Right**: Use of a directional mic to improve the range of detection

Plans going forward

- Data collection for model improvement
- Calculating the practical threshold of data classes, that edge can detect.
- Use of drone amplitude as a weight factor for precise triangulation
- Optimizing the gateway device to improve the trajectory calculation
- Improving the detection accuracy with an airborne UAV to track and follow
- Improving our current web based platform for more user interaction

Microphone array sensor for calculating the direction

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