Advanced Sensing Technologies for Threat Awareness and Mitigation

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Advanced Sensing Technologies for Threat Awareness - RB

Objectives: Develop sensors and sensing systems to detect and identify threats within Soft Targets and Crowded Places

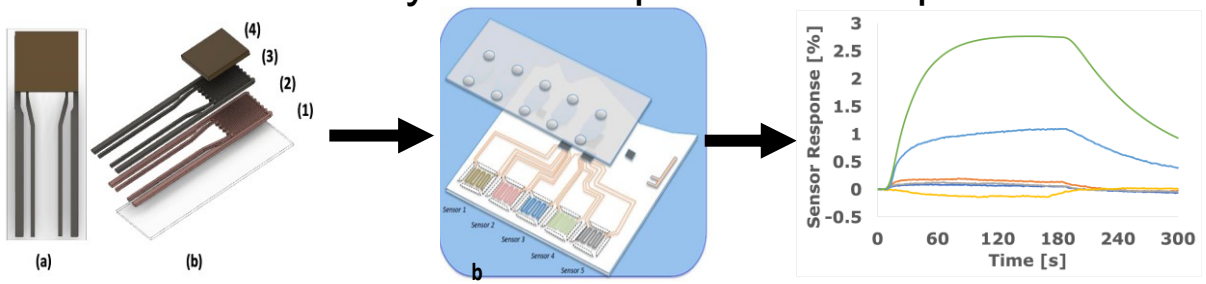
- Research and develop pervasive, inexpensive, networked sensors to detect unusual concealed objects:
  - Large metallic objects: firearms, IEDs
  - Items with characteristic chemical signatures: explosives, gun oil
- Explore a range of sensors for fixed (on building or streetlight) and mobile (drone) deployment
  - Near-in vapor detection
  - Standoff laser telescopic chemical analysis
  - Multi-beam mm-wave high resolution imaging radar
  - RF situational awareness sensing
- Explore new sensing innovations for threat detection as they become available
- Interface with Virtual Sentry Framework to efficiently provide actionable sensor info
- Work with industry to engineer devices for eventual field implementation

RB.1: Chemical Sensors

RB.1A: Multi-Sensor Threat Assessment Platforms Otto Gregory (URI) and Jimmie Oxley (URI)

The Digital Dog Nose (DDN)

- Heat from catalytic decomposition of vapor



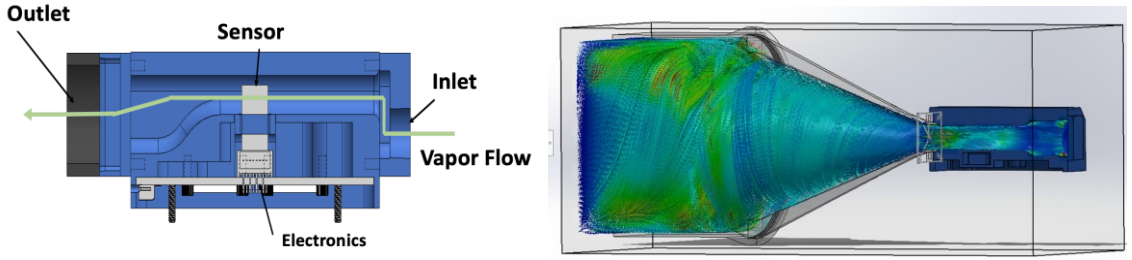
Sensitivity: (ppq)

Specificity: Unique differentiation of multiple analytes

Response Time: <2s

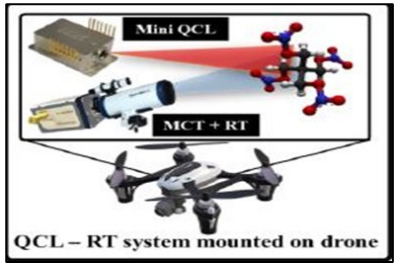
High throughput vapor sampling and active sniffing biomimetics

- Flow rates 330x dog's nose
- Standoff detection distance 16X

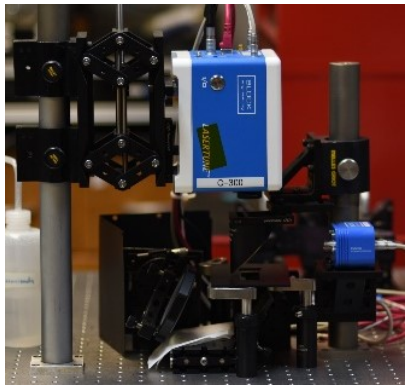


RB.1B MIR-LBS Multisensors: Detecting CBTs & other Chem Threats Using QCL Spectrometers (QCLS)

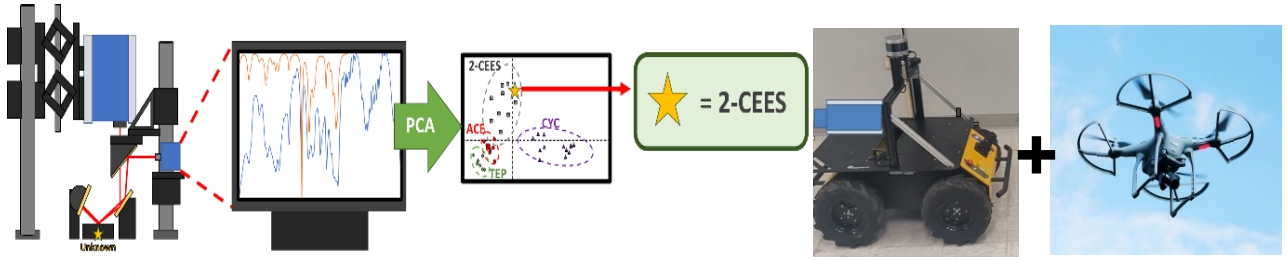
Samuel P. Hernández-Rivera (UPRM)



Spectra of CBTs simulants using Grazing Angle Probe-QCLS



- AI and ML models of CBTs trained with PCA models that explain their spectral variation
- Goal: Autonomous sensing using unmanned vehicles

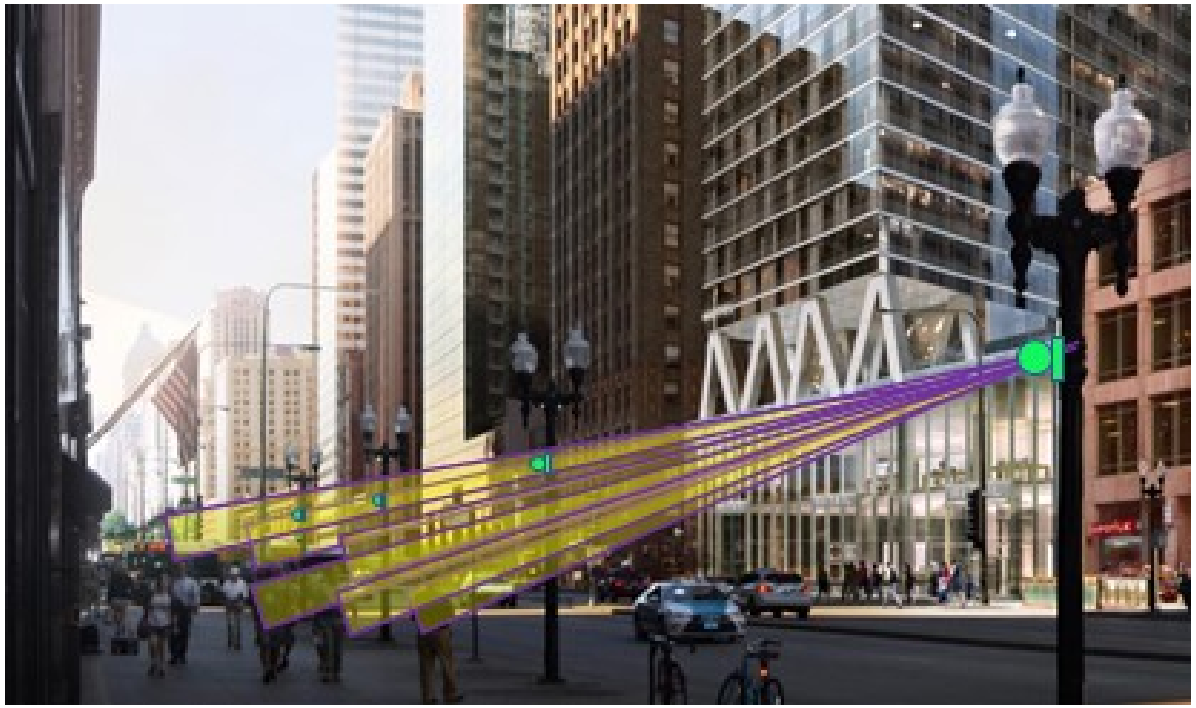


RB.2: Electromagnetic Sensors for Threat Detection and Crowd Situational Awareness

RB.2A: Active mm-wave radar sensing of large concealed metallic threats

Carey Rappaport (NEU)

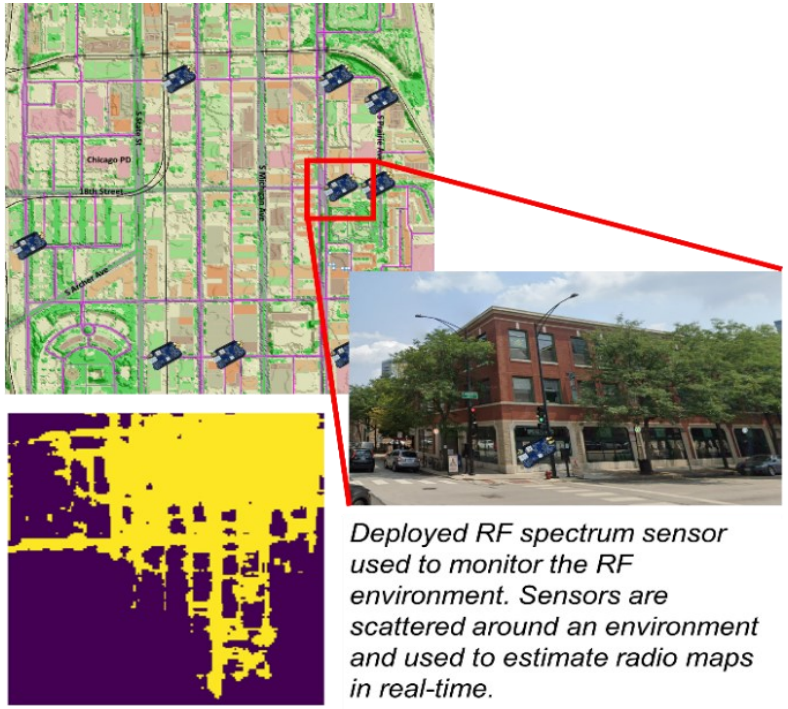
- Advanced inexpensive multibeam antenna design
- Video tracking to cue radar
- AI image interpretation



RB.2B: Passive RF to locate and see behavior of crowds

Scott Howard (ND)

- Distributed emission energy sensor network
- Neural networks and tomographic (Bayesian) reconstruction of emission maps
- Antennas for high spatial resolution

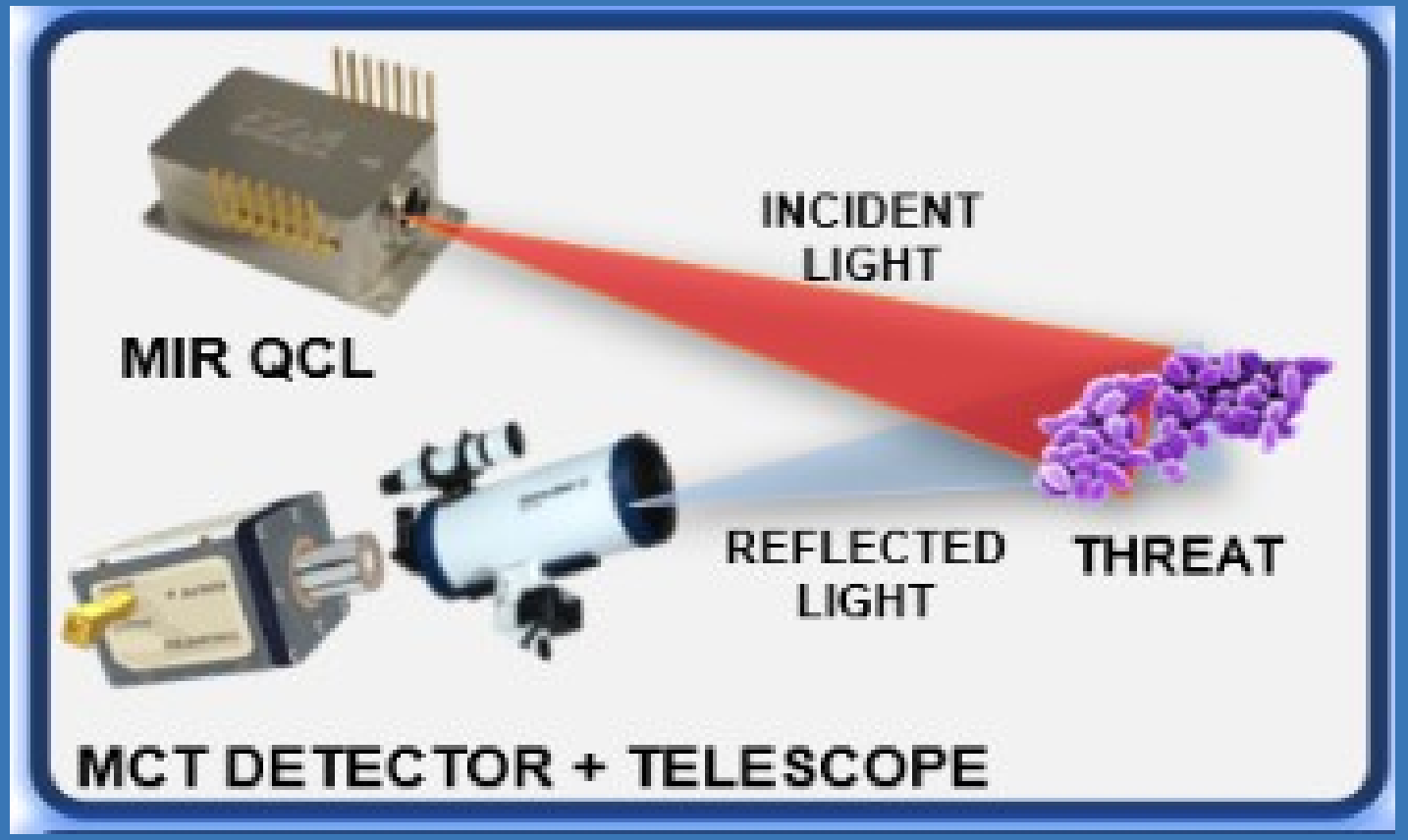


Deployed RF spectrum sensor used to monitor the RF environment. Sensors are scattered around an environment and used to estimate radio maps in real-time.

Standoff Chemical Detection of Threats

Develop novel laser sensors with sufficient sensitivity to detect & track distant vapor plumes

- Quantum cascade laser (QCL), mid-infrared (MIR) laser spectroscopy, and reflected light telescope, all aimed at a vapor plume
- Detection distance as far as 300m
- Grid can detect plumes in any defined space
- Amenable to mobile platforms
- QCL systems mounted at check points may detect vehicle bombs before they enter cities



Digital Dog Nose Sensor Fingerprinting: Gun Oils & Interferents

- The DDN sensor ”fingerprint” for two different gun oils compared to 2 primary oil ingredients and 3 interferents
- Gun oils produce a unique signature to that of the interferents upon interaction with the DDN sensor catalysts
- Selectively identify concealed firearms from their associated gun oils
- Additional gun oils and propellants (black powder) have been acquired to add to our library

	Al_2CuO_4	CuO	Fe_2O_3	ITO	MnO	SnO	WO
Hoppe's No. 9	+	-	-	+	+	+	+
Rem Oil	NR	-	-	+	NR	+	NR
2-propanol*	-	-	-	+	+	+	+
Ethanol*	+	-	+	-	-	+	+
Deodorant	NR	-	NR	+	NR	+	NR
Perfume	+	-	NR	+	NR	+	NR
Toothpaste	NR	-	NR	+	+	+	+

***Primary gun oil ingredients**

Legend:
Green (+) → Positive Response (Endothermic)
Red (-) → Negative Response (Exothermic)
NR → No Response

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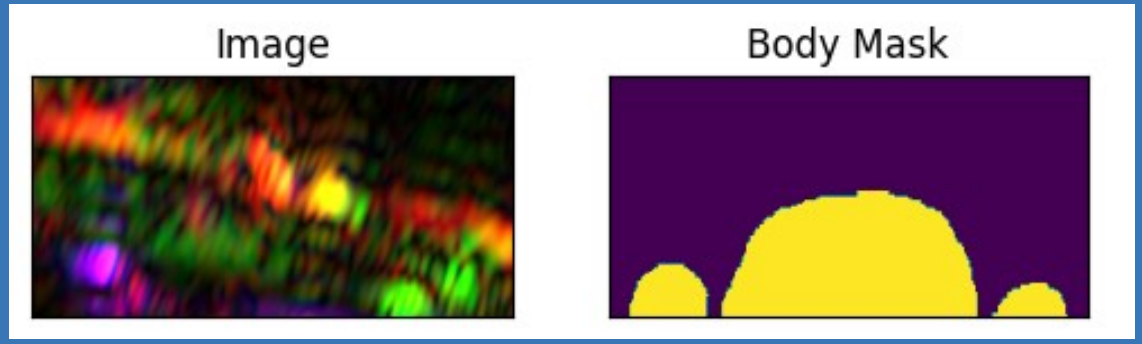
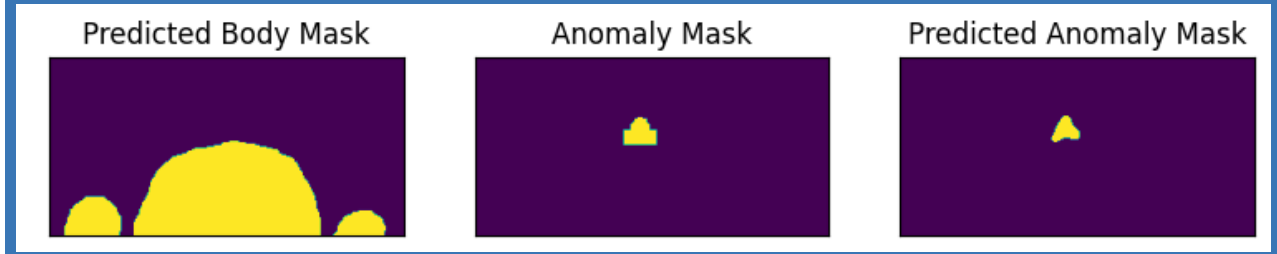
Radar Detection of Concealed Threats in Crowds at Distance

- Stationary pole-mounted inexpensive multi-beam radar
- Coupled with video for tracking suspicious individuals
- Multiple views enhances imaging -- ISAR
- Scans city sidewalk
- Detects concealed metallic threats on pedestrians
- Uses AI target prediction





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RF Situational Awareness

- Real-time picture of crowd behavior
  - Supplement video camera with “invisible” radio frequency (RF) emissions from cell phones, electronics, and vehicles
  - RF emissions finds location/size of groups and their behavior (frequencies and power form a “signature” of device behavior)
- Network of low-cost (<$100 each) sensor nodes deployed as fixed infrastructure or on drones for ad-hoc infrastructure (e.g., temporary events)
- Project Aims
  - Develop the **network infrastructure & data analysis** for Virtual SENTRY framework

“RadioHound” RF sensing nodes

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