INNOVATING CROSS-DOMAIN SOLUTIONS TO DETECT EMERGING BIOLOGICAL THREATS

Miniaturized Airborne Threat Assessment & Detection Sensor (MATADOR)

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Sponsored by the Defense Threat Reduction Agency (DTRA), Johns Hopkins Applied Physics Lab (JHU/APL) is currently developing a miniature sensor termed the Miniaturized Airborne Threat Assessment & Detection sensOR (MATADOR). The size of the current design is 2.8 centimeters (cm) × 2.8 cm × 0.64 cm and weighs 14 grams. Material costs are approximately $160 per sensor. Sensing capabilities include frequency, temperature, humidity, pressure, acceleration, and orientation. With its small footprint, low cost, and real-time detection capability, the MATADOR could have a range of applications, including early-warning of a threat cloud, smart triggering of identifier systems, and leave-behind applications. There are also potential applications in other areas such as medical, food industry, and environmental monitoring.

Activities from FY20 to present-day have focused on sensor prototyping, proof-of-concept testing, electronics design, and algorithm development. Great progress has been made, advancing the sensor to a state in which it is a low size, weight, and power (SWAP) standalone sensor with an anomaly detection algorithm incorporated. The sensor has successfully demonstrated detection of chemical vapors, both in a laboratory setting and during open airfield tests.

The MATADOR operates using the mechanism of quartz crystal microbalance (QCM) sensing. A detection event is determined based on a change in frequency beyond the established threshold. In its current form, the sensor cannot differentiate between benign materials and chemical or biological threats, therefore, JHU/APL has planned future work to add selectivity and/or specificity to the sensor. Based on current literature, the surface chemistry of the QCM could be altered to allow certain types of particles to bind or interact more directly to the surface due to physical interactions caused by properties such as polarity, hydrophilicity, etc. Various coating materials such as polymers, carbon nanotubes, etc. can be explored that may increase affinity for specific materials and allow for selectivity. Selectivity could include the capability to distinguish chemical from biological, vapor from aerosol, or determine the class of a chemical or biological agent. It is also conceivable that specificity can be added to the current sensor to detect a particular biological or chemical agent of interest (e.g., Bacillus anthracis or sulfur mustard) by coating it with antibodies or molecularly imprinted polymers (MIP).

Future efforts will use the MATADOR as a testbed to develop an approach to incorporate selectivity or specificity into the existing design. The goal is to add capability to the sensor and provide early, real-time, actionable information to the Joint Forces during operations.

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