Washington University in St. Louis
Office of Technology Management

BIO-ROBOTIC "ARTIFICIAL NOSE" SYSTEM FOR DETECTING EXPLOSIVES AND OTHER CHEMICALS

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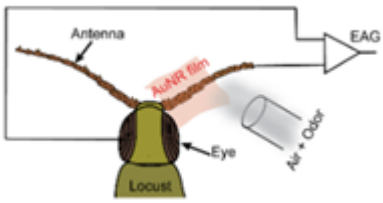
Technology Description

Prof. Barani Raman and colleagues have developed a robust, insect-based, non-invasive sensing system to detect explosives or other chemicals. This "artificial nose" technology includes methods to decode neural signals from the insect's olfactory system and a communication system using "plasmonic nano-tattoos" to steer the insect remotely.

Hybrid insect-electronic sensor systems could offer elegant solutions for complex engineering problems if appropriate interfaces can be developed to integrate external components (optical, electronic and mechanical) into the insect "bio-robot". This technology provides such interfaces for a locust model system designed to detect explosives (e.g., TNT, DNT, RDX, PETN) or other volatile chemicals. This includes: an array of electrodes that records and decodes neural signals from the insect olfactory system; and a non-invasive nano-tattoo that controls the locust's movement by generating localized heat. The nano-tattoos can guide the locust to regions of interest while the signals from the insect olfactory system can be more robust, sensitive and specific than non-biological sensors. These insect-based bio-robots could be tuned for a range of sensing applications including environmental monitoring, diagnostics, defense and security applications.



Schematic of plasmonic nano-tattoo*: The nano-tattoo (AuNR film) is transferred to the insect (shown on the antenna but could also attach to a compound eye or wings), the tattoo can then steer the insect and/or be functionalized to detect specific odors.*

Stage of Research

The inventors have demonstrated an operational system for:

- Odor recognition – specific neural signals recorded from locusts can be decoded with machine learning tools to detect a range of chemical vapors, including several explosive chemical species (TNT, DNT, RDX, PETN)
- Remote control navigation – "plasmonic nano-tattoos" can optically steer a locust to a region of interest and the nano-tattoos can be integrated with detection elements to analyze the chemical environment in that region

Publications - Nizampatnam, S., Saha, D., Chandak, R., & Raman, B. (2018). Dynamic contrast enhancement and flexible odor codes. *Nature communications*, 9(1), 3062.

Applications

- **Chemical sensing** –remote, insect-based "artificial nose" detection with potential end-user applications such as:
  - homeland security – explosives or drug detection
  - environmental monitoring
  - medical diagnostics
- **Bio-robotics** – nano-tattoo communication system could be utilized for remote control of insects to be used in other applications

Key Advantages

- **Robust, accurate sensing –** harnesses biological olfactory organ with potential for better sensitivity and selectivity than all-electronic devices:
  - less susceptible to variations in humidity
  - consistent responses over time
- **Non-invasive, powerless navigation –** seamlessly integrates onto insect tissue and guides them to areas of interest without compromising sensing functions

Additional Publications

- Light-activated nanoheaters may control nerve cells, locust mind, McKelvey School of Engineering News, Aug. 29, 2019
- Locusts help uncover the mysteries of smell, theSource, Aug. 3, 2018

Related Web Links – Raman Lab