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The Smart Trap

Real-Time Autonomous Surveillance for Vector-Borne Pathogens

The Smart Trap, developed at Sandia National Laboratories, performs autonomous surveillance for mosquito-borne viruses, and transmits data to cloud-based monitoring system via cellular networks.

Current Biosurveillance Tools Are Insufficient

Mosquito-borne pathogens are a menace worldwide. Malaria and dengue significantly burden both civilian and military populations in the tropics, and emerging arboviruses pose health and security risks across the continental U.S., e.g., West Nile virus, chikungunya virus, and now Zika virus. While the risks posed by arboviruses are well known, surveillance for vector-borne diseases is constrained by limited budgets, and a reliance on laborintensive techniques for sample collection and analysis.

The Smart Trap

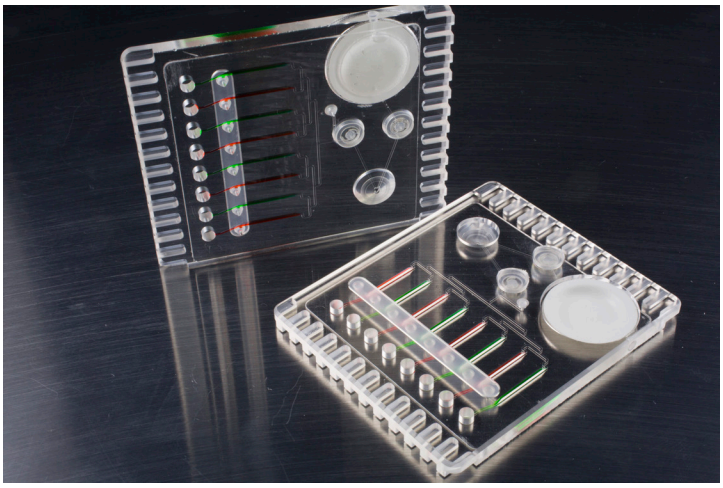
In collaboration with UC Davis, we have developed a device that automates a novel approach to detecting arboviruses in a field setting, based upon the sugar feeding behavior of mosquitoes. Mosquitoes (hostseeking or not) feed upon plant-based sugar on a daily basis for energy. Infected mosquitoes can deposit anywhere from 1-10,000 plaque-forming units of virus on a sugar bait, which we detect by RT-LAMP in 30 min with an autonomous shoe-box sized microfluidic instrument.

Automated Processes

The trap presents microfluidic chips to mosquitoes and automatically handles all microfluidic chip manipulations, including onboard buffer dispensing, pneumatic chip filling, heating, and fluorescence endpoint detection.

Networked Biosurveillance

Traps are intended to be inexpensive enough ($500 each, upon scale up) to deploy in a mesh network, allowing daily reports at multiple locations within a region of interest. We built an app to provide access to trap data sorted by date or location, as well as map visualizations. Mapping incorporates a statistical model that predicts vector abundance based upon environmental factors. The app is available to analysts within the U.S. Defense Threat Reduction Agency's biosurveillance ecosystem (BSVE).



Above: Plastic (PMMA) analysis chip with dried reagents for up to six virus-specific RT-LAMP assays, plus controls.

Conclusions and Future Work

- The Smart Trap detects <1 PFU of a 6 virus panel from sugar feeding mosquitos with low false-positive rate in 30 min.
- The Smart Trap is designed for mass manufacture at low cost ($500 per trap, $10 per chip).
- The Smart Trap can be reconfigured to target other pathogens.

Commercialization path

We are seeking commercial partners to achieve scalable manufacturing of both the trap hardware and consumable assay cartridge. For the cartridge, we seek manufacturers with expertise in injection molding of devices compatible with biological assays and molecular diagnostics, as well as expertise in producing dry-stabilized reaction mixes. For the hardware, we seek improved ruggedization for outdoor environments including heat, cold, and inclement weather, as well as simplifications that allow lower cost manufacturing without compromising performance. Target markets include military entomological units, and state and county-level public health or vector control agencies.

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