

Towards Comprehensive Biological Agent Detection: Introducing the HoloZcan Multi-Modular System

The urgency for comprehensive platforms capable of detecting airborne biological agents has never been greater. Existing systems, however, fail to fulfill key criteria such as rapid detection, portability, user-friendliness, and multiplex capability.

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Challenges

Biothreat detection requires balancing speed, accuracy, and adaptability to manage biohazard risks and sample variability. Innovative solutions, like integrating bio-detection with robotics, are needed to overcome the limitations of imprecise and slow systems and to develop new measurement protocols, particularly useful in heterogeneous environments where measurements on a limited number of points risk missing critical data. A multi-disciplinary approach, combining microbiology, data science, engineering, and public health, is crucial for creating effective and adaptable biothreat detection systems for future challenges.

System Design

HoloZcan-Compact device collects airborne particles in aqueous media and automatically analyses them after drying using a microscope. The aqueous-based collection is beneficial for biological agents, balances the variable water content of the particles and allows the mostly agglomerated particles to be broken up by surface-active additives.

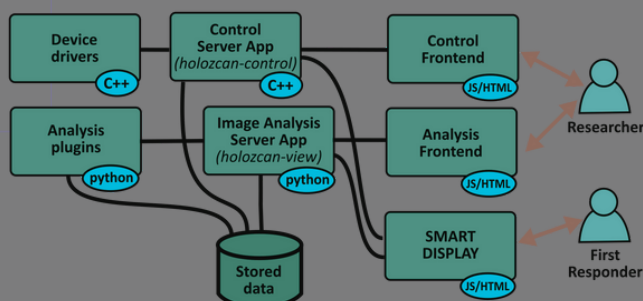
In the design of the system, we have tried to address the existing challenges and uncertainties by using a portable and modular design. Each module is connected by a sample disc, which can be rotated to different positions by the system. In addition to the interchangeable collection and sample preparation module, a multi-modal (holographic + fluorescence) microscope and an AI accelerator module are also available, in addition to the basic electronics configuration required.

On the first version of the instrument (see figure), the collection is performed by an impactor, but thanks to the modular design, it can be replaced by a cyclonic sampler or connected to an external high performance collection system by means of a capillary system. Instead of the upper sample disc, a standard microscope slide adapter can be used – in this case, sampling is performed independently and the entire slide is scanned by the HoloZcan- Compact.

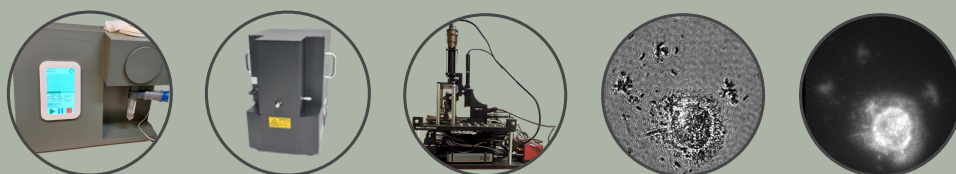
Auxiliary sensors: motion, THP (replaceable), GNSS
Interfaces: WiFi, Bluetooth, Ethernet, USB, GSM
Size ~ 16 x 20 x 36 cm
Weight: ~ 3kg

Software System Architecture

Software architecture is inextricably linked to the R&D workflow. Easily transferring research results into field testing was one of our goals. In research phase, many AI algorithms have been proven to classify aerosols based on scattering and fluorescence properties. In our architecture, these research AI methods are connected via plug-ins (or bridge of plug-ins) to generate a comprehensive report on the measured data.



Design Evolution Path



HoloZCAN

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