

A Modular Housing System for a Novel, Automated Microfluidic Solution Testing and Toxin Detection System

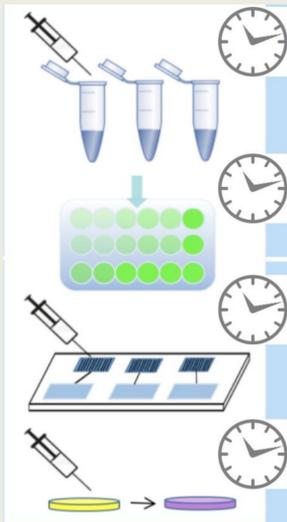
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Introduction

Despite a wide variety of biosensors available for use to detect toxins in water, testing them in different aquatic environments is a long, complex process. Our solution aims to speed up the testing of biosensors through an automated microfluidic droplet generation and sensing system.

Microfluidics

- Moves nanoliter quantities of fluid through a chip
- Mixes liquid by turning liquid through channels
- Generates droplets by pinching water through a flow of oil, creating isolatable reaction systems



Biosensors

- Contain a biological organism that can detect a toxin after incubation
- Can be sensitive to the specific environment that it is being run in
- Provide a fluorescence/luminescence/color output that can be recorded through a microscope/camera

Automation

- Speeds up the testing process
- Provides repeatability and scalability
- Can be implemented with any microfluidic system

Future Directions

- Implement timing mechanism to coordinate water and oil pumping throughout the system
- Integrate microfluidic chips into system along with a sensing system
- Downsize system and improve portability
- Cheaper liquid displacement to improve reproducibility
- Create a standardized system to implement new combinations of microfluidic chips and biosensors

References

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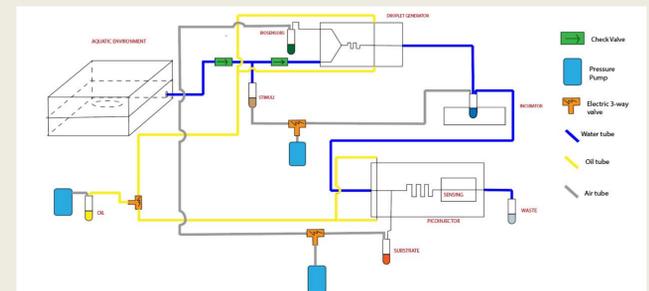
Design Process

Constraints

- Minimize size and dead space in order to reduce the weight of the final product and maintain efficiency of the system
- Similar components must be located together in order to reduce the complexity and length of wiring/tubing
- Shelving units separate wet and electric components as well as microfluidic chips
- Pumps, tanks, and microfluidic chips must be easily accessible for maintenance

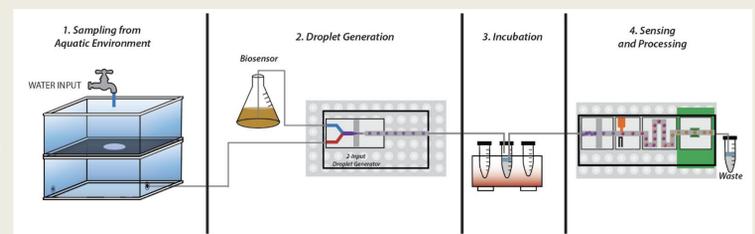
3D Modeling

- Helps visualize system before prototyping
- Custom parts must be designed to ensure that all parts of the system remain fully secured
- Pumps were held in 3D printed holders
- AutoCAD and Fusion360 were used to design housing components to secure pumps and valves



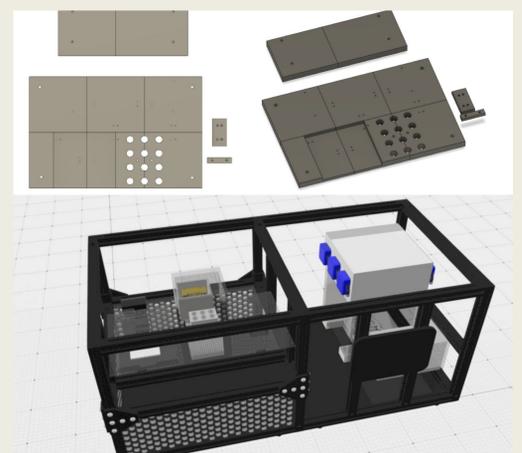
Rapid Prototyping

- Fast, simple way to test if a design plan meets the design constraints
- Can be modified through the use of a standardized system before design finalization
- All housing components were first prototyped before being implemented



Device

- Created an adjustable system to test the position of components on six, attached acrylic sheets
- Determined that incubator must be lowered and pumps must be raised to provide access to tubing
- Connectors were created to adjust length of platform
- T-slotted beams were used as the primary framework to support the device and hold shelving units
- Acrylic sheets were used as the base for shelving units, secured to the framework with connectors
- Modular housing design separates tanks from rest of housing



3D models of rapid prototyping

- Two input chip was fabricated as the first chip in the system, generating water droplets in oil
- Housed on a raised platform to allow access from upper lid
- Output of chip sent to test tube located in the incubator

- Depressions/elevations added to shelving units to keep pumps and incubator accessible
- Lids placed at the top and sides to allow for easy access to interior components and electronics



Device fully assembled and connected to power source



Organization of internal components of device

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