# A Fully-Integrated and Self-Contained Lab-On-A-Chip Device for Sample Preparation, RNA Amplification, and Detection for Disease Diagnostics

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RNA-based infectious diseases have been sources of large-scale epidemics and pandemics resulting in millions of casualties worldwide. Detection of these biological agents normally involves many lab processes including sample preparation, nucleic acid separation and amplification, and detection. These steps, either performed manually using pipettes or automatedly using bulky and costly instruments, are tedious, expensive, and highly susceptible to cross-contamination. In this project, an integrated and self-contained lab-on-a-chip device was developed for sample-to-answer biological analysis of RNA-based infectious diseases. The device consists of: 1) an acoustic-based micromixer that enhanced target cell lysis and mixing between target RNA and magnetic beads for RNA capture; 2) on-board reagent storage blisters that also serve as pumps and valves; 3) an electrochemical micropump; 4) single-use wax microvalves; 5) a chamber to perform RNA concentration and purification; 6) a chamber to perform RNA isothermal amplification. Acoustic micromixing was optimized to significantly reducing mixing time from 6 hr to 7 sec. The electrochemical pump was successfully demonstrated in a one-pump flow system and characterized to optimize the capture/retention of RNA. Lastly, a battery-powered portable instrument was developed to control the mechanical operation of the device. The integrated, self-contained device successfully performed sample-to-answer genetic analysis of Chlamydia Trachomatis and Mycoplasma Genitalium from human urine samples. This technology demonstrates a potential of integrating the entire genetic diagnostic process into a handheld device, completely independent of external apparatus, for the diagnosis of hundreds of infectious diseases.

**Awards Won:**

Third Award of $1,000

University of Arizona: Tuition Scholarship Award

NASA: Second Award of $750

International Council on Systems Engineering - INCOSE: First Award of $1,500