Live Demonstration: Sample-to-Answer Nucleic Acid Testing Device for Point-of-Care Applications

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***Abstract*— We demonstrate a sample-to-answer nucleic acid testing device. The streamlined nucleic acid sample processing, including DNA extraction, amplification, and real-time detection, are achieved on a single microfluidic reagent disc by actuating the DNA-carrying magnetic beads against stationary reagent droplets. The battery-powered handheld instrument is unprecedentedly integrated with mechanical, thermal and optical subsystems with data connectivity. LCD touchscreen and smartphone connectivity offer a user-friendly interface for easy operation. This versatile platform can be widely disseminated to a variety of other situations that demand portability, connectivity, and ease-of-use.**

Keywords*— *Nucleic acid tests, point-of-care, malaria, non-centrifugal, lab-on-a-disc

I. Introduction

One of the significant challenges for nucleic acid testing (NATs) at the point of care is related to the front end of the assays - nucleic acid extraction from raw samples [1]. The ideal sample preparation should be simple, scalable and easy-to-operate. In this demo, we present a sample-to-answer portable nucleic acid testing device, which facilitates streamlined sample processing including DNA extraction, amplification, and real-time detection. The nucleic acid bearing magnetic beads were moved to the desired liquid chambers on the microfluidic disc by energy efficient magnetic interaction. This innovation enables a unique method for high-quality nucleic acid sample preparation and detection on a single enclosed microfluidic reagent disc. In addition, it greatly simplifies the complex DNA analysis and offers low-cost, low-power and accurate diagnosis performance in a quick and automated fashion.

II. Demonstration Setup

The example demo setup is depicted in Fig. 1. The instrument for demonstration only requires standalone analyzer, microfluidic reagent compact disc, 9V rechargeable battery, and cable. All modules for thermal, optical, mechanical subsystems and data connectivity are pre-installed in the microcontroller unit (MCU), which controls the streamlined sample processing with minimal user intervention. During the demonstration, real-time optical sensing data can be seen through an embedded LCD touchscreen or smartphone interface. Nothing but the table, poster stand (or panel) and power outlet for recharging the battery is required to run the live demonstration.

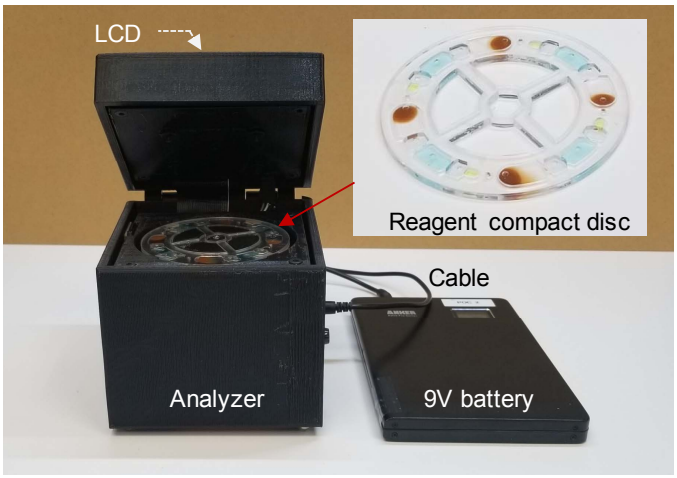

Fig. 1. Demo setup consists of the handheld analyzer and 9V portable external battery, wire cable, and microfluidic reagent compact disc. The LCD touchscreen is located on the top side of the lid.

III. Visitor Experience

During the demonstration, the visitor will see the overall workflow of the device operation. The workflow consists of the four steps; sample collection, loading, processing, and result report. To explain the streamlined DNA sample processing, we will show the charge-switchable magnetic bead actuation against the stationary droplets using reagent compact disc. To demonstrate the thermal, optical subsystems, and data connectivity, temperature, and optical sensing data will be real-time monitored and displayed on an LCD touchscreen or smartphone. Underlying nucleic acid sample preparation and amplification assay, detailed hardware and software design will be explained during the demonstration.

Earlier Publication

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