

1. Disc fabrication

The detailed layout of the disc is shown in Figure S1. The disc is composed of two types of PMMA structures and two types of pressure-sensitive membranes: the topmost pressure-sensitive membrane, the upper pressure-sensitive membrane, the channel layer, and the chamber layer. The topmost pressure-sensitive membrane has a single fixed hole in the center, serving to extend the shelf life of the disc and prevent premature movement of the liquid. The upper pressure-sensitive membrane has openings at the injection and venting points, serving as the inlet for liquid introduction while maintaining pressure equilibrium. The channel layer contains channels connecting various chambers, which may include siphon valves, capillary valves, and centrifugal pneumatic valves, controlling the flow of liquids within the disc. The chamber layer comprises the sample chamber, detection area, activation liquid chamber, waste chamber, and others.

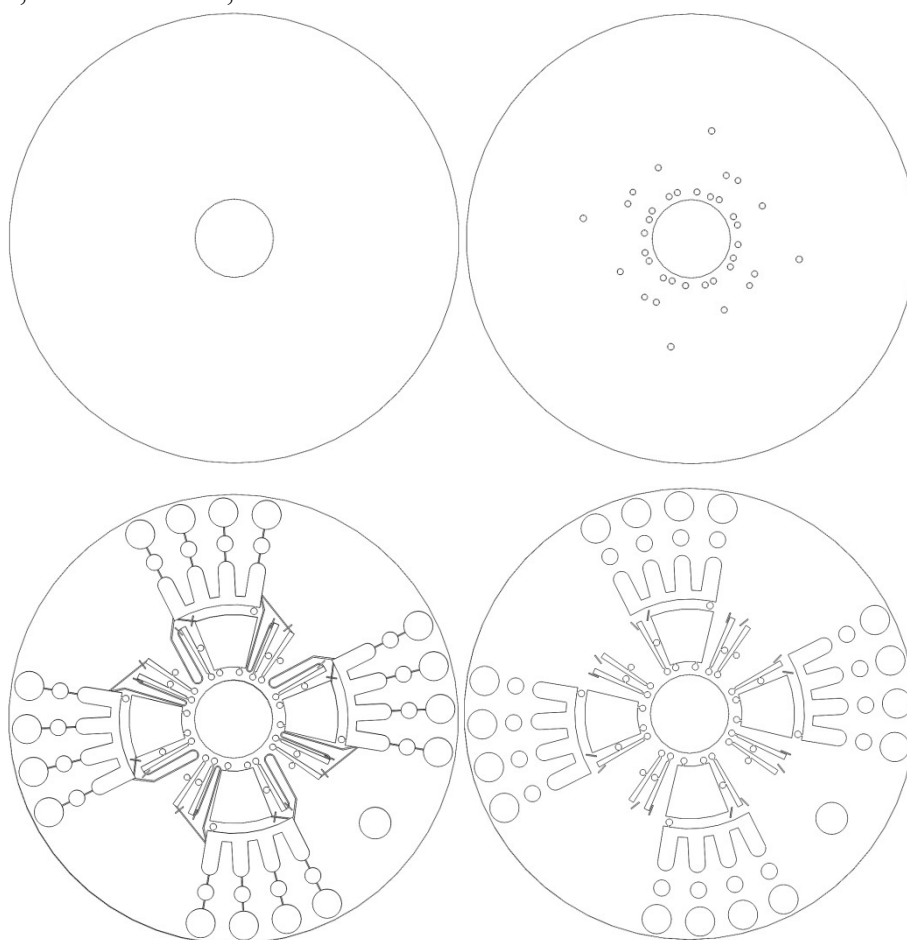


Figure S1. Four-layer structure of the disc. (A) Topmost pressure-sensitive membrane (thickness: 0.02 mm). (B) Upper pressure-sensitive membrane (thickness: 0.02 mm), including inlet and venting holes. (C) Channel layer (thickness: 0.02 mm), containing channels connecting various chambers. (D) Chamber layer (thickness: 1 mm), comprising chambers for liquid movement. The diameter of the disc is 170 mm, and the central fixed hole has a diameter of 15 mm.

2. Experimental set-up

The experimental setup is shown in Figure S2. The disc device is mounted on an RF-300FA-11420 centrifugal motor with a rated voltage of 3V and a rated speed of 3000 rpm. The instrument is controlled by an STM32 microcontroller. A fixed circular LED light source and a diffuser plate are positioned above, with the center of the circular light source aligned with an OV7670 camera. The light source, camera, diffuser plate, and chip are parallel and aligned along the same vertical axis, ensuring consistent illumination conditions and uniform distribution on the disc during each measurement. The detection results are transmitted via Bluetooth to the corresponding mobile app.

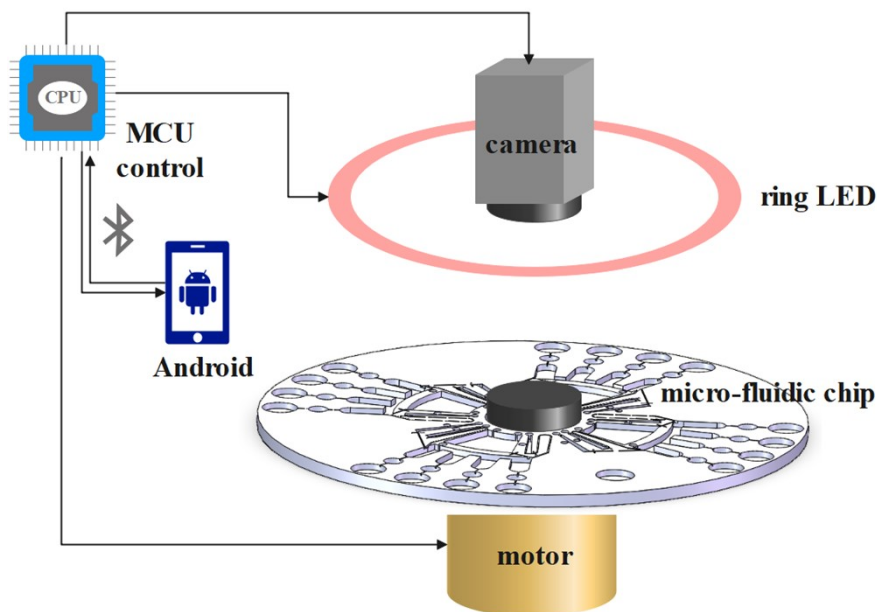


Figure S2. Experimental setup for detection. It includes a centrifugal motor, a circular light source, a camera, a control unit, and a Bluetooth module, all integrated into our experimental apparatus.