Affordable Nanoparticle-Based Diagnostic Device for Rapid and Precise Detection of Pandemic-Causing Diseases

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This project introduces a low-cost, portable diagnostic device for the rapid and accurate detection of pandemic-causing diseases. During the COVID-19 pandemic, millions of people lacked access to timely and reliable testing. These delays allowed viruses to spread silently, often before outbreaks were even recognized. When harmful pathogens such as the Coronavirus, Ebola virus, or Dengue virus enter the human body, specific antibodies, such as Receptor Binding Domain (RBD) nanobodies and Immunoglobulin G (IgG), bind to antigens on the pathogen surface to help prevent infection. This device mimics that immune response by using gold nanoparticles coated with nanobodies to detect viral antigens. When antigens are present in a blood or saliva sample, the nanoparticles bind to them and aggregate, causing a visible color change from red to pink. The device features a 3D-printed photodetection chamber connected to an Arduino board, which controls an LED and a photodiode placed on opposite sides of a test tube containing the antigen-antibody solution. As the nanoparticles aggregate, the system electronically measures changes in light intensity and quantifies the severity of infection based on signal variation. Results are generated in under 15 minutes, with the entire system costing less than $20 to build and each test under $1 to perform. This portable device merges the speed and affordability of rapid tests with the accuracy of ELISA and PCR, all without the need for a laboratory. Its simple design makes it ideal for use in clinics, schools, and remote or resource-limited areas. Beyond viral detection, the platform can be adapted for drug testing and real-time public health monitoring, paving the way for a faster, more accessible future in diagnostic technology worldwide.

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