Digital COVID-19 test designed to alleviate pandemic's burden on developing countries

By Monisha Ravisetti
May 22, 2021

Addressing the terrors that COVID-19 continues to inflict on developing and overpopulated countries, particularly India, scientists designed a portable deep-learning system that is built with inexpensive and easy-to-use equipment and tests for infection in real time.

Because it's constructed from 3D-printed materials and can be built by anyone with access to a 3D printer and the necessary instructions, the product avoids lengthy and costly shipping limitations. Further, some parts can be repurposed from commonly found items, such as laser pointers, laptops and smartphones. The mechanism was described in a paper published May 4 in *Optics Letters.*

"I have been looking at optical instrumentation in a way that can be very compact, can be very low cost and can be effective for particularly poor parts of the world," lead author Bahram Javidi, a professor in the Electrical and Computer Engineering department at the University of Connecticut, told *Fastinform.*

While the pandemic has ravaged countries around the world, the present devastation in India is unparalleled. Within the span of a few months, the Indian government has reported a staggering number of new cases and deaths — May 20 alone saw 259,269 new cases and marked a total of 291,365 deaths nationwide.

There is also wide speculation that even these statistics are undercounts, especially considering the lack of health care resources and undetected cases in remote villages — indicating a need for not only better information output but also easier access to testing devices.

Many researchers have been looking to formulate novel ways of diagnosing the disease. One group from the U.K. proposed breakable capsules filled with scented oils. A main symptom of COVID-19 is the loss of the sense of smell, and the mechanism tests whether people can detect various scents that fill the capsule.

Javidi's portable instrument, on the other hand, contains a laser source, a camera and a piece of glass, upon which a small blood sample is placed; the device is also connected to a smartphone or laptop.

As the laser's light propagates the sample, the camera captures a digital hologram of the red blood cells, and their data is uploaded to a downloadable application on the computer. From there, the computer reconstructs the digital hologram via the app and detects any abnormalities in blood cells that can be linked to a positive case of COVID-19.

The entire process is completed within minutes — or even seconds, depending on the laptop or smartphone being used.

"I thought because laptops are so ubiquitous, you make the instrument cheaper by not including the hardware," Javidi explained.

He noted, however, that if there is demand for the data-processing hardware to be built into the device, such an addition is possible. But without that adjustment, the design is light, small and versatile.

"You can take this into the field. You can hold it in your hand and operate it. You can put it on a regular desk or a chair and operate it," Javidi said. "This system can be used in practice in remote areas."

The team's device uses digital 3D holograms of red blood cells because blood cells carry a significant amount of compositional and dimensional markers indicating whether a person is healthy or infected.

"Think of the red blood cells as having a 3D volume with lots of complex information inside," Javidi said. "And if the person is healthy, these red blood cells correspond to a healthy condition — but as diseases are introduced, the content of these red blood cells change."

Just as a human heart beats, red blood cells have a sort of pulse, too. But a simple image of a red blood cell isn't able to capture that, which is why Javidi's digital hologram

approach has another advantage in the detection of disease and blood cell abnormalities.

"In a healthy person, the red blood cell beats differently than someone with an illness — just like a healthy person walks in a certain way versus someone who has a very serious condition," he said.

The novel prototype rapidly finds those changes and compares them with infected cells. Further, because it can address all anomalies in blood cells, the system can be manipulated to detect illnesses other than COVID-19, too.

Javidi has already found the device to be effective in testing for malaria, sickle cell disease and breast cancer. It's adaptation to various diseases depends on the app's algorithm, which can be altered accordingly.

"We can also reconstruct the red blood cells for hematologists to look at," to further examine the cells and disease, Javidi said. "Or it could simply [provide] an answer: 'Yes, this is COVID; no, it's not COVID.'"

And the test requires only the ability to retrieve blood from a patient via a simple finger prick — not unlike the type commonly used to detect blood-sugar levels in patients with diabetes. That means highly skilled medical workers aren't needed to run the system. It can even be used at home.

Javidi relayed that he and his team sincerely hope that they can make a contribution to addressing this "terrible pandemic."

"It's really wreaking havoc on the world."

The paper, "Digital holographic deep learning of red blood cells for field-portable, rapid COVID-19 screening," published May 4 in Optics Letters, was authored by Timothy O'Connor, Jian-Bing Shen, Bruce T. Liang and Bahram Javidi, University of Connecticut.

Correction: A previous version of this article misidentified Bahram Javidi's department. The error has been corrected.