SARS-CoV-2 Point of Care Sensing Platform for Mutation Identification

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Abstract

- A miniaturized and portable sensor having SARS-CoV-2 receptors, enabling a point of care (PoC) system platform for three SARS-CoV-2 variants: alpha (B.1.1.7), beta (B.1.351), and delta (B.1.617.2).
- Accurate, rapid, and fully integrated wireless readout electronic system with smartphone data visualization.
- Sensitive detection of SARS-CoV-2 with a limit of detection (LOD) of 5.14 and 2.09 ng/mL for the S1 and S2 proteins in the linear range of 1.0 - 200 ng/mL, respectively.
- Successful COVID-19 diagnosis based on a clinical study with 63 nasal swab samples.
- Our point of care diagnostic system is comparable to state-of-the-art RT-PCR, antibody blood, and IgG and IgA ELISA test results.

Introduction

Monitoring the pandemic remains critical to efficiently manage the situation. As a crucial cellular receptor, Angiotensin-converting enzyme 2, known as ACE2, enables the direct entry the virus into the host cell.

Here we describe a method to identify variants alpha, beta and delta, from the United Kingdom, South Africa and India. We achieve an accuracy of 99.37% accuracy by using the Tiny Machine Learning approach.

Materials and Methods

Sample collection and sensor preparation

- Laser-scribed graphene (LSG) sensors are coupled with gold nanoparticles (AuNPs).

Results

- Sensing performance and sensitivity

  - ACE2 can recognize S proteins in mutations with higher accuracy.
  - Higher S1 and S2 binding observed in alpha, beta and delta variants.

  - Clinical trials

- 63 patient nasal swab samples were tested with RT-PCR and our diagnostic system.

- Our diagnostic system has 100% agreement with RT-PCR test.

- 98.7% accuracy in inferring Beta (B.1.351) variant, 99.5% accuracy in inferring Alpha (B.1.1.7) variant, 100% accuracy in inferring Delta (B.1.617.2) variant, 98.9% accuracy for control (negative) patients

- ~1 minute for DPV and 20ms for inference.

References


Conclusion

- Early, low-cost, easy-to-use PoC detection of disease biomarkers is critical for managing global health issues.
- Identification of mutations, alpha, beta and delta originated from the United Kingdom, South Africa and India with PoC device.
- The validation of device performance as a self-diagnostic platform was achieved by a machine learning (TinyML) algorithm.
- We have achieved a low cost < $ 50 PoC platform.
- The presented solution provides fast SARS-CoV-2 variant detection (~1minute) with high accuracy between positive and negative case (100% agreement with RT-PCR).
- Our PoC system offers a potential platform for future SARS-CoV-2 variants.

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