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IIT-I develops quantum-AI nanotechnology for DNA sequencing

Our Staff Reporter
INDORE

A research group at Indian Institute of Technology (IIT), Indore has developed a new technology, namely, "Quantum-AI Nanotechnology" aiming to revolutionize unified DNA sequencing by fusing quantum transport with explainable AI.

The primary problem addressed by this technique, which is developed by a team led by Prof Biswarup Pathak, Dr Sneha Mittal and Dr Milan Kumar Jena from the Department of Chemistry, is the need for rapid, high-resolution, and cost-effective natural, epigenetic, and artificial DNA sequencing. It can accurately identify genetic mutations, including those associated with cancer.

Traditional sequencing methods, such as Sanger sequencing and short-read next-generation sequencing (NGS), often fail to detect complex genetic variations, including structural variants and modifications that are crucial for understanding genetic disorders and cancers.

The technology leverages solid nanopore/ nanogap devices to measure transverse tunneling electric readouts, enabling unified sequencing across the genomes. The core objective is to deliver rapid, high-resolution sequencing for natural, artificial, chemically modified, and epigenetically modified DNA by capturing the unique electronic signatures of nucleotides as they traverse the nanopore.

The research findings have been published in the prestigious journals: Nano Letters, ACS Central Science, ACS Materials Letters, ACS Applied Materials & Interfaces, The Journal of Physical Chemistry Letters and Nanoscale among others. IIT Indore director Prof Suhas Joshi said, "These methods provide limited read lengths, which can miss important genomic information. The Quantum-AI nanotechnology with a solid-state nanopore/ nanogap device has the potential to overcome this by providing high-resolution detection of nucleotides as they pass through the device, capturing unique electronic signatures that precisely identify genetic mutations."

Quantum-AI nanotechnology employs advanced AI algorithms to decode the raw electric signals with exceptional speed, accuracy, cost-efficiency, and overcoming the long-standing limitations of traditional sequencing methods. The integration of explainable AI ensures that the sequencing results are not only accurate but also transparent and interpretable, enhancing confidence in the results. Pathak said "This technology has transformative implications for genomics, personalized medicine, and cancer diagnostics, facilitating the early detection of genetic mutations and cancerous transformations. By enabling personalized treatment strategies and improving patient outcomes, this invention empowers researchers and clinicians with a powerful tool to decode genetic information across a broad spectrum of genomic contexts, marking a significant leap forward in DNA sequencing with unmatched precision and clarity."