Porcupine: Swift and Versatile DNA-based Molecular Tagging

The use of DNA to make molecular tags, or nano-scaled “barcodes”, promises to use pre-existing expertise in manipulating biomolecules to invisibly track and identify objects of interest in a difficult-to-forge way. However, the synthesis of such biomolecules is by no means inexpensive, and current efforts in this space require large overhead and take long times to decode a tag. This technology solves both issues by providing an easy-to-use approach to DNA-based molecular tagging, able to be decoded in real time with an inexpensive, portable device.

What is the Problem?

Barcodes are pervasive in today's world, used to track and identify various objects. However, they come with limitations: they struggle with objects that are too small, flexible, or numerous, or have specific requirements such as invisibility. Molecular tagging presents a promising solution, leveraging nanoscale footprints and extreme difficulty to forge. Yet, existing methods of molecular tagging often require specialized labs, expensive equipment, and long times to read and write.

Advancements in biotechnology have moved biological molecules, particularly DNA, to the forefront of efforts in molecular tagging. The current landscape still reveals a gap in a cost-efficient and time-efficient method for both the creation and reading of these DNA tags. In its current form, DNA tagging still requires costly steps such as laboratory synthesis of unique tags, and computationally expensive methods of reading the tags.

What is the Solution?

The technology presents an innovative system offering a swift and accurate tagging solution, empowering y easy creation of a large number of unique tags. Instead of requiring the synthesis of entirely new biomolecules, the technology simplifies the tag creation process by using a set of 96 pre-programmed DNA fragments. Each tag contains 96 bits, each bit denoting the presence or absence of one of the DNA fragments. Users can mix these fragments arbitrarily to create new tags, using readily available equipment (centrifuges, thermal cyclers, and mixers).

Another unique aspect of the technology is its ability to decode tags in real time, without the need for the intensive process of fully sequencing the DNA. Using a portable and cost-effective sequencing device (such as Oxford Nanopore Technologies' MinION), the technology recognizes tags based only on the raw ionic conductivity data given by the device. The DNA fragments are meticulously designed to be easily distinguishable in this raw data, ensuring fast and accurate

Technology ID

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Category

Hardware/Storage
Selection of Available Technologies

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decoding on the fly.

What is the Competitive Advantage?

While DNA-based molecular tagging is not a new concept, the technology introduces two pivotal advancements: the use of pre-made DNA fragments, and the analysis of raw ionic conductivity data for decoding rather than relying on sequencing.

Firstly, the pre-made DNA fragments are designed to be easily distinguishable in the raw data, ensuring that any random mixing provides a unique tag. This eliminates the need for complex biomolecule synthesis, streamlining the tag creation process and enabling the generation of over seven octillion tags with ease.

Secondly, on the data analysis front, the technology harnesses cutting-edge techniques such as convolutional neural networks and dynamic time warping to create an evolutionary model to decode the raw signals. This model, combined with an inexpensive, portable sequencing device, enables real time decoding, a significant leap forward in molecular tagging technology.

Patent Information:

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