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Reframing Signal Drift: An AI-Based Approach for Functionalized Graphene Sensors

Graphene field-effect transistors (GFETs) are powerful tools for detecting a variety of biological and chemical substances, including ions, glucose, DNA, and proteins, due to their exceptional sensitivity to electric fields. Although non-functionalized GFETs have performed well, especially when combined with Artificial Intelligence (AI), this study centers on the use of functionalized GFETs. These devices incorporate molecular probes that selectively bind to target DNA sequences on the graphene surface, enabling highly specific detection at extremely low concentrations. Despite their enhanced selectivity, functionalized GFETs remain susceptible to interference and signal drift. This study explores their application in detecting bacterial DNA and evaluates their performance under realistic conditions. A major limitation of conventional detection methods is the tendency to simplify analysis by focusing only on limited regions of the sensor's output, discarding complex signal segments that may hold valuable information. Rather than aiming to generalize across devices, the primary objective of this study is to investigate whether the typically discarded regions of GFET signal data contain meaningful patterns. By applying Deep Learning to the complete "V"-shaped transfer curves, this approach reveals insights into the operational behavior of functionalized GFETs, improving data utilization and informing the design of more robust biosensing systems.

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