MODSIM PortSeqXR Abstract

Title: An Extended Reality Assistant Improves Performance of an Austere Genomic Sequencing System for Novice Users.

Abstract: Miniaturized genomic sequencing technologies offer transformative potential for far-forward identification of biological hazards. However, widespread adoption across a range of applications, both military and civilian, is hindered by specialized training requirements, protocol complexity, poor reproducibility, and challenging result interpretation. We address these barriers through an extended reality (XR) assistant for the Noblis Portable Sequencing and Analysis System (NPSAS), a portable far-forward genomic sequencing capability based on Oxford Nanopore technology. Our prototype system reduces training requirements, decreases cognitive load during protocol execution, and improves reproducibility among novice users. Using Unity Engine, we developed visual and audio cues delivered via the Meta Quest 3 headset to guide users through NPSAS protocols and evaluated the impact on users familiar with basic laboratory techniques but naïve to these protocols. Preliminary results demonstrate that the XR assistant reduces procedural errors, accelerates system orientation, and increases user confidence while performing a soil metagenomic sequencing protocol. Future development will incorporate artificial intelligence-driven protocol adaptation for diverse environments and sample types, automated metadata collection, integrated data analysis, and real-time technical/scientific reachback when operational circumstances permit. The use of XR assistants offers an extensible and generalizable means to make complex equipment and procedures, including those used for austere genomic sequencing, immediately more accessible to users of varying levels of technical expertise operating across a wide range of mission sets.

Learning Objective 1: Describe how extended reality technologies can reduce training barriers and cognitive load for complex field-deployable genomic sequencing protocols.

Learning Objective 2: Evaluate the impact of XR assistant systems on user performance metrics including error rates, orientation time, and confidence levels during protocol execution.

Learning Objective 3: Identify key design considerations and future capabilities needed for implementing XR-based guidance systems in far-forward biological detection operations.

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Projected Track: Emerging Capabilities