جامعة حمد بن خليفة
HAMAD BIN KHALIFA UNIVERSITY
عضو في مؤسسة قطر
Member of Qatar Foundation

HBKU Thematic Research Grant 3rd Cycle– Project Highlight

Project Title: AI-Assisted Smart Interventional Needles with Engineered Acoustic Surfaces for Robust Ultrasound Visualization

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Executive Summary (limit to 200 words)

Ultrasound-guided medical procedures often suffer from limited needle visibility, particularly when the needle is viewed at steep or oblique angles. This poor visibility can obscure the needle tip, leading to diagnostic uncertainty, longer procedures, and, in some cases, the need to switch to more expensive or radiation-based imaging methods.

This project explores a new generation of smart medical needles that use advanced acoustic engineering and artificial intelligence to achieve clear, consistent visibility under ultrasound imaging. The design employs structured surfaces with directional acoustic return and machine-learning algorithms that recognize and track the needle's position in real time. Together, these innovations aim to deliver sharper, more angle-independent imaging performance and more reliable tip localization during interventions.

By improving ultrasound guidance, the work supports safer, faster, and more cost-effective procedures such as biopsies and regional anesthesia. The outcomes will contribute to Qatar's growing leadership in medical technology and intelligent healthcare systems while laying the foundation for future integration with robotic and minimally invasive platforms.

Expected Outcome (limit to 100 words)

- Concept Development and Simulation: Computational modeling and acoustic design of structured needle surfaces integrated with AI-based tracking to enhance ultrasound visibility and tip localization.
- Prototype Development: Fabrication and benchtop validation of functional smart needle prototypes demonstrating enhanced contrast and angle-robust performance compared to standard needles.
- Knowledge and IP Generation: Foundational know-how, publications, and invention disclosures in acoustic design and AI-assisted ultrasound imaging.