Wearable, implantable, and ingestible technologies for precision mental health

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Abstract

Globally, 615 million people suffer from depression and anxiety, yet there's still no reliable, objective way to monitor mental health. Barriers such as stigma, high costs, and limited access to care prevent many from seeking help. To address this, we developed a low-cost, scalable wearable using electronic skin and flexible hybrid electronics. It continuously tracks stress-related physiological markers—heart rate variability, skin conductance, sweat rate, and cortisol. Using sensor data and analytics, we quantify mental states to inform user-centered design. In this talk, I'll present a wearable for mental health, along with a multi-phase study that integrates user feedback and engineering data to shape future devices. These wearables offer discrete, remote monitoring for improved mental wellness. In the second part of the talk, I'll introduce our work on implantable and ingestible devices to better understand the brain–gut connection. While ingestibles offer a user-friendly format, accurate localization is a challenge. We address this with a magnetic-field-based 3D localization system, achieving mm-scale accuracy. Our ingestible pill integrates optoelectronic gas sensors to detect oxygen and ammonia—a proxy for H. pylori, linked to ulcers and gastric cancer. We also demonstrate pH sensing using a custom-designed, self-orienting ASIC capsule optimized for GI tract wall contact. Overall, this talk will highlight key hardware innovations in wearable, ingestible, and implantable medical devices aimed at tackling critical challenges in precision mental health. For more information regarding our work, please visit: khan.usc.edu

Bio

Yasser Khan joined the Department of Electrical and Computer Engineering at the University of Southern California as an Assistant Professor in 2022. He earned his B.S. in Electrical Engineering from the University of Texas at Dallas and his M.S. from King Abdullah University of Science and Technology. Dr. Khan completed his Ph.D. in Electrical Engineering and Computer Sciences at the University of California, Berkeley in 2018. Before joining USC, he was a postdoctoral researcher in the Department of Chemical Engineering at Stanford University. Dr. Khan's research centers on additive manufacturing and hardware-enabled AI, developing wearables, implantables, and ingestibles for precision health and psychiatry. He received the 2025 Air Force Office of Scientific Research Young Investigator Award, the 2024 Packard Fellowship, the 2023 Google Research Award, the EECS departmental fellowship at UC Berkeley, the Discovery Scholarship and graduate fellowship at KAUST, and the Academic Excellence Scholarship at UT Dallas. With over 60 research papers published on leading platforms, Dr. Khan's work has been featured by BBC News, the Wall Street Journal, and NSF News.

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