Date: 1st July, 2024 (Monday)

Time: 4 pm

Venue: RM 101, Rajeev Motwani Building, Department of Computer Science and Engineering

Speaker: Navajit Singh Baban (New York University, Abu Dhabi)

Title: Microfluidic Biochip Security

Abstract:

Microfluidic biochips (MBs), a prominent class of lab-on-a-chip, are widely used in clinical diagnostics, point-of-care testing, and biomedical research. They have been rapidly commercialized and deployed for numerous biomedical applications. However, their complex supply chain has exposed MBs to attacks based on malicious intent and IP theft, posing serious concerns for patient healthcare. We work towards addressing these vulnerabilities by identifying potential attack vectors and developing robust cyber-physical security solutions to safeguard MBs. Specifically, we have investigated structure/architecture- and material-level attacks on commercial MBs. For instance, structure-level attacks include malicious modifications that reduce the heights of micro-reaction chambers, potentially resulting in faulty diagnostics. To counter such attacks, we have developed a DL-based detection scheme that has achieved an accuracy of approximately 96% in identifying these microstructural anomalies. Material-level attacks, on the other hand, involve the deliberate degradation of an MB's material components, using tactics such as stealthily degrading with reactive or harmful solvents or deliberately altering the material's chemical composition during fabrication. Such stealthily modified biochips tend to evade quality checks and fail during usage, thus fulfilling the attackers' motives. To detect material-level threats, we employed machine learning (ML) models trained on force-displacement data from mechanical punch tests, which successfully detected material-level anomalies with over 99% accuracy. Moreover, to combat biochip IP theft-related attacks, we have proposed innovative device-level watermarking, fingerprinting, and physically unclonable functions (PUFs) that can be used in image-based and spectral-based authentication. These proactive countermeasures are designed to secure MBs against such vulnerabilities, ensuring their integrity in the face of global pandemics and the advancing field of personalized medicine.

Bio:

Dr. Navajit Singh Baban is currently a postdoctoral associate at NYU's Center for Cyber Security, focusing on securing microfluidic biochips. Additionally, he works on biomechanics, particularly bioinspired fracture and adhesion mechanics for nature-inspired innovation. He holds a B.Tech. degree in Mechanical Engineering from VIT University, Vellore, and an M.Tech. in Materials Science from the Indian Institute of Technology, Kanpur. He obtained his Ph.D. as a Global Ph.D. Fellow from the Department of Mechanical and Aerospace Engineering at NYU, USA, in 2021. As a firm supporter of nature-based innovation, he deeply values the inscrutable wisdom of natural solutions and aims to discover and incorporate them into his research.