University of Pittsburgh | School of Computing and Information

Dissertation Defense
Doctor of Philosophy in Information Science
with a focus in Telecommunications

"**Wireless Solutions for Improving Healthcare:**
Contact Tracing and Hand Hygiene Monitoring"
by **Akshay Madan**

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Place: Room 502, Information Sciences Building, 135 N Bellefield Ave., Pittsburgh, PA, 15213

Committee:

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Abstract:
The healthcare sector increasingly faces disruptions that demand advanced strategies, robust systems, and innovative solutions to tackle emerging challenges. One significant disruption has been the COVID-19 pandemic, which has claimed over 6.9 million lives globally. Its rapid spread and the emergence of new variants highlight the importance of preventive and screening measures such as vaccination and contact tracing. Contact tracing identifies individuals exposed to infected persons, allowing timely interventions like isolation and testing. A common method of digital contact tracing (DCT) involves using smartphones with Bluetooth to broadcast and register close contacts. However, current Bluetooth-based approaches suffer from low accuracy due to limited control over range. Furthermore, most DCT efforts focus on direct contact, such as touching or talking, while neglecting indirect contact, such as exposure to contaminated surfaces or respiratory particles.
Another critical issue in healthcare is healthcare-associated infections (HAIs), which, according to the World Health Organization (WHO), are a leading cause of morbidity and mortality in healthcare settings. One major contributor to HAIs is the failure of healthcare workers (doctors, nurses, etc.) to consistently adhere to hand hygiene protocols. This factor also contributes to the transmission of infections like COVID-19 within hospitals. Ensuring proper hand hygiene compliance (HHC) can significantly reduce the incidence of HAIs.

This dissertation addresses both of these challenges. First, it aims to enhance the accuracy of DCT while safeguarding user privacy. This is achieved through the deployment of Bluetooth-based IoT devices in public gathering spaces, such as restaurants, hospitals, and schools, which enables the detection of both direct and indirect contacts. Additionally, we extend this approach to support bidirectional tracing, identifying additional contacts arising from asymptomatic carriers. Second, the dissertation proposes a deep learning-based system that utilizes WiFi channel state information (CSI) to monitor hand hygiene compliance. By recognizing handwashing or hand-rubbing motions, this system can detect non-compliance and help enforce hygiene protocols, ultimately contributing to the reduction of HAIs.