Proposal Defense
Doctor of Philosophy in Intelligent Systems

"**Designing Contextual-Adaptive Displays to Support Situational Awareness in Human-Autonomy Teaming**" by **Yaohan Ding**

Date:	December 10, 2025
Time:	Noon – 2 p.m.
Place:	Room 301, Information Sciences Building, 135 N Bellefield Avenue, Pittsburgh PA 15213

Committee:

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Abstract:

Autonomy is increasingly deployed by human teams in high-stakes domains to improve task performance. For these human-autonomy teams to succeed, high autonomy capability is necessary but insufficient; humans must also maintain appropriate situational awareness to ensure timely, safe intervention when the system encounters vulnerabilities such as unexpected events or failure. The information display through which humans interact with autonomy is the primary tool for building this critical understanding. The proposed project aims to advance human-autonomy teaming by designing and validating novel adaptive displays to help humans maintain adequate situational awareness in challenging conditions. The first stage aims to design and validate display strategies to support human situational awareness within single-human, single-agent teams in safety-critical environments. I developed distinct information displays rooted in human information processing theory to address scenarios where automated driving system performance is compromised. Specifically, I designed explainable displays for recognizing system malfunctions, alert-explanation displays for defending cyberattacks, and criticality-adaptive displays for managing highly interactive traffic environments. Their effectiveness was evaluated across three user studies, utilizing a diverse set of simulated driving scenarios to ensure generalizability across operational contexts. The results provide a robust foundation for the contextual adaptation of information displays to improve situational awareness, informed by specific scenario characteristics and quantified individual user differences. The second stage escalates the research scope to multi-human, multi-agent teaming, with the core objective of enhancing team situational awareness in complex operational environments. Based on a role-based information requirements analysis, I propose importance-coded and urgency-coded display mechanisms and will validate them with rigorous empirical user studies featuring high-fidelity, drone-based search and rescue simulations. In addition, I will utilize multimodal physiological and behavioral signals, such as eye-tracking and Electroencephalography (EEG), to construct a predictive model of situational awareness. This model will subsequently enable real-time

adaptive information display by strategically modulating display saliency to direct user attention toward critical, yet previously under-recognized elements. I anticipate that role-specific, dynamically adaptive displays will significantly facilitate cognitive resource allocation, leading to enhanced team situational awareness and task performance.