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Attend virtually: https://udel.zoom.us/j/99615073260

CYBERSECURITY AND QUANTUM COMPUTATION IN CONTROL OF CYBERPHYSICAL SYSTEMS FOR NEXT-GENERATION MANUFACTURING

Next-generation manufacturing refers to upgrading production procedures to achieve greater agility and efficiency by making use of computing, sensing, and networking systems that can facilitate greater production autonomy, flexibility, and responsiveness while enhancing the accuracy and comprehensiveness of process monitoring/diagnosis and reducing down time. One of the most critical elements of a next-generation manufacturing system is the control systems. These systems automate process operation through the computation and communication of actuator actions to final control elements such as valves and heaters, based on sensor readings. Physical systems interfaced with computing systems that directly manipulate their behavior in this fashion are termed "cyberphysical systems." These systems have unique requirements for real-time availability, error rejection, safe design, and flexibility compared to computing and networked systems that are not interfaced directly to engineering hardware. Some of the most pressing demands for cyberphysical systems in the process industries today are that they be increasingly hardened against cyberattacks without compromising efficiency and that they increasingly raise profits while preventing accidents through rapid assessment of the ideal decisions for process operation. In this talk, we will describe our work in the development of detection policies for cyberattacks on the controllers of cyberphysical systems, and will also discuss our preliminary work in evaluating impacts of the imperfections in today's quantum computers on the success of implementing control laws on these devices. Our group has developed detection strategies for detecting cyberattacks on control systems (on the actuators, sensors, or both at once) which are tightly integrated with an advanced, optimization-based control algorithm known as model predictive control. We will discuss the design of these methods based on control-theoretic principles to evaluate their ability to maintain safety of the plant when attacks occur on the controllers but are undetected. In addition, we will discuss our work to date on the investigation of the implementation of controllers on quantum computers. The long-term motivation for this work is that it remains unclear what the benefits of quantum computers may be for control. We hypothesize that by exploring how control and quantum computing interact (and particularly exploring the control-theoretic implications of using these computers given potential non-determinism in the results from their computations), we can provide insights into types of algorithms on quantum computers that may be well-suited for control. This may guide algorithm development or may help to reveal whether or not quantum computation should be considered as a useful technology for control design or not. We will analyze of the results of computing a control action on a quantum simulator incorporating a noise model for a simple single-input/single-output linear system, and consider safety guarantees for a process under an (inefficient but illustrative) quantum algorithm which searches a lookup table containing control actions from an advanced control law with some probability.

ABOUT THE SPEAKER

Helen Durand is an Assistant Professor in the Department of Chemical Engineering and Materials Science at Wayne State University. She received her B.S. in Chemical Engineering from UCLA, and upon graduation joined the Materials & Processes Engineering Department as an engineer at Aerojet Rocketdyne for two and a half years. She earned her M.S. in Chemical Engineering from UCLA in 2014 and her Ph.D. in Chemical Engineering from UCLA in 2017, and subsequently started at Wayne State. She received the Air Force Office of Scientific Research Young Investigator award, and her work has also received support from the National Science Foundation including the CAREER award. She received a Faculty Research Excellence Award and an Excellence in Teaching Award within the College of Engineering at Wayne State University and served as the chair of the Next-Gen Manufacturing Topical Conference for the 2021 Annual Meeting of the American Institute of Chemical Engineers.