Student Presentation Session I

11:00 am – 11:30 am

Alex Wong — Optical Super-microscope: Imaging beyond the diffraction limit

Optical microscopy suffers from a fundamental resolution limitation arising from the diffractive nature of light. Most current solutions to sub-diffraction optical microscopy involve combinations of near-field, non-linear and fine scanning operations, which hinder their use as a tool for general purpose microscopy. In contrast, we have recently proposed and demonstrated an optical super-microscope (OSM) – a linear imaging system with far-field working and observation distances. The OSM operates through a phenomenon called superoscillation – where for a finite duration a waveform oscillates faster than its highest constituent frequency component. Harnessing superoscillatory optical waves, our OSM achieves far-field, sub-diffraction optical imaging without the need for fine scanning, data post-processing or object pre-treatment. In this talk I will overview the origin of the diffraction limit, explain key considerations which led to the development of the OSM, and present preliminary experimental results which demonstrate the OSM's ability to improve a device's imaging resolution beyond the diffraction limit.

Yao-Hong Kok — Fault tolerant control systems: an introduction

Technology advances have improved the performance of many industrial control systems by adding more components to systems, which subsequently increases their complexity. A fault or failure in one of the components in a system can alter system behavior, which may lead to hazardous consequences. Examples of such systems would be airplanes and nuclear power plants. Owing to the large number of components and the cost of the components, hardware redundancy to handle failures can only be deployed for the most mission-critical components. To maintain safe and reliable operation of a system while reducing the reliance on hardware redundancy, substantial research effort has been devoted to active fault-tolerant control system (FTCS). My talk will introduce the basic concept of FTCS and some of the recent development in the field.

Shuthakini Palendran — Control of voltage source converters for synchronous machine emulation

Synchronous generators (SGs) are the major contributors in maintaining the stability of power systems. As SGs are displaced by electronically-coupled distributed energy resources (DERs), the dynamic behaviour of these new generation technologies will become critical in ensuring grid stability. One method of ensuring continued provision of voltage and frequency regulation is to have these new devices emulate the response of traditional SGs. Achieving the desired emulation requires fast, robust control of DERs to track the rapid changes in current injections that arise when SGs are subjecting to changing grid conditions. Hence, this research focuses on the feasibility of controlling a voltage source converter to emulate the behaviour of a SG during both steady-state and transient periods. Two types of hysteresis current controllers (HCCs)---standard and space vector based---are considered for tracking the current injections of a virtual SG in real-time. Through simulation, it is demonstrated that both HCCs provide robust, fast tracking that enables the desired emulation, but they exhibit a wide range of variations in switching frequencies. Hence, this research proposes a dead-time control method and demonstrates that the switching frequencies can be limited while maintaining the quality of voltages and currents that are compatible to the IEEE 1547 standard.