

COLLEGE OF ENGINEERING

# Control Seminar



Sponsored by: Bosch, Ford, and Toyota

## Towards a Rigorous Framework for Optimal Selection of Basis Functions in Feedforward Tracking Control – and Beyond



### CHINEDUM OKWUDIRE

Associate Professor, Mechanical Engineering  
Associate Chair, Integrative Systems and Design  
University of Michigan

Friday, March 20, 2020

3:30 – 4:30 pm 1500 EECS Bldg.

**ABSTRACT:** Basis functions (BFs) are used extensively in control engineering. For example, they are used to tackle various challenges in feedforward, iterative learning, and model predictive control, to mention a few. In these and other similar applications, the standard practice is to solve a given control problem by pre-selecting a set of BFs (from a wide range of available options) based on user preference or engineering intuition. Case in point is the emerging filtered basis functions (FBF) approach for feedforward tracking control of non-minimum phase systems using BFs. Rather than the standard practice of arbitrarily selecting BFs, in this talk, we will present a rigorous framework for selecting optimal BFs that minimize control effort or maximize robustness for a desired level of tracking accuracy using the FBF approach. The optimal BFs have been shown in simulations and experiments on 3D printers to yield orders of magnitude improvement in control efficiency and robustness compared to popular BFs like B-splines, while maintaining the same level of (nominal) tracking accuracy. Extensions of our work to adaptive and nonlinear systems will be outlined. Much of this work has been performed in collaboration with Prof. Emer. A. Galip Ulsoy.

**BIO:** Chinedum Okwudire joined the University of Michigan in 2011. Prior to joining Michigan, he was the mechatronic systems optimization team leader at DMG Mori USA. His research is focused on exploiting knowledge at the intersection of machine design, control and, more-recently, computer science, to boost the performance of manufacturing automation systems at low cost. A major application area of his research is 3D printing automation. Chinedum has received a number of awards for his work and has co-authored a number of best paper award winning papers in the areas of control and mechatronics.

Keval Ramani completed his Ph.D. and M.S. from University of Michigan in 2019 and 2015, respectively, and B.E. from BITS Pilani, Goa Campus, India, in 2012. His research interests are in control, dynamics, vibration and optimization, with application to manufacturing automation. He is a co-author of the best student paper award winning paper on FBF at the 2015 *Dynamic Systems and Control Conference*.



Questions? Contact: Judi Jones [asap@umich.edu](mailto:asap@umich.edu)