Robust Control Strategy for Implementation of Artificial Pancreas in Sedentary Diabetes Patients

Monday, October 13
1037 Emerging Technologies Building
9:10 a.m.

The problem of Insulin Dependent Diabetes Mellitus (IDDM) management is very complex due to the great inter- and intra-patient variability in physiology. A variety of factors may cause fluctuations in the glucose metabolism ranging from variability in the meal and exercise profiles to human intervention in implementing the control strategies. In this work, robust model based strategies are proposed for glycemic control using both the intravenous (IV) and subcutaneous (SC) insulin infusion routes. For glycemic control in critically ill patients using IV infusion, an input-output data based modeling approach is adopted with a state estimation based offset-free model predictive controller. Also presented is a model predictive controller with zone control algorithm which mimics the natural feedback involved in glycemic control of healthy subjects by employing a range for set-point. For ambulatory diabetics who are on intensive insulin therapy, a self-tuning algorithm is suggested to adjust the insulin dosage in a multiple daily injection regimen (MDIR) via the SC route. This algorithm uses a model based adaptive optimal control strategy involving bi-level optimization for parameter estimation and optimal insulin dose estimation. Both the IV and SC strategies are validated on simulation studies of diabetes patients under various patient-model mismatch and multi-meal scenarios.

Before joining the Artie McFerrin Department of Chemical Engineering at Texas A&M University, Dr. Karim served as professor of chemical engineering at Texas Tech University. He has been a visiting professor at Helsinki University of Technology, Technical University of Denmark, Osaka University and the University of Newcastle upon Tyne. Trained in process control and optimization theories, he has been involved in biotechnology research for the last 22 years. Examples of his recent research topics are the application of online model predictive control of recombinant fermentations (e.g. E coli, CHO cells) and the use of data based approaches such as Neural Networks and Principal Component Analysis, to classification, fault detection and identification of bioprocesses. Dr. Karim also is involved in research areas such as lignin biodegradation and recombinant fermentation for ethanol production from mixed substrates. His recent research activities involve regulation of apoptosis in mammalian cell culture, proteomic data-analysis for metabolic pathway modification, and effects of shear stress on t-PA protein production in CHO cells. Funding for his work has come from the National Science Foundation, USAID, the Department of Energy, and the Colorado Institute for Research in Biotechnology, and various industries. In addition, Dr. Karim is director of the successful short course, “Advanced Industrial Bioprocessing,” offered every year for the biotechnology industries.