

Neuro-fuzzy inverse optimal control incorporating a multistep predictor as applied to T1DM patients

Abstract

Emerging technologies seek to provide effective solutions to the most severe health problems such as type 1 diabetes mellitus (T1DM). In fact, the number of diabetics around the world has increased as well as the mortality rate associated with this condition. T1DM is caused by an autoimmune failure which disables the pancreas to produce insulin; therefore, glucose is not correctly metabolized to be used as efficient energy. Consequently, the most important fact is to keep the patient's blood glucose level within normal ranges in order to avoid long-term complications. Recently, engineering innovative approaches based on intelligent systems such as artificial neural networks have been proposed for control in biomedical systems. In this work, a novel neuro-fuzzy control scheme for blood glucose regulation in virtual T1DM patients is proposed. The glucose-insulin dynamics is modeled by a recurrent high-order neural network and then a neural multistep predictor is incorporated in order to know the glucose behavior within a 15-min horizon; thereby, allowing the knowledge of future values to determine the convenient basal infusion insulin rate as defined by the fuzzy membership functions. Test using the well-known Uva/Padova simulator illustrated that the proposed neuro-fuzzy controller maintains normoglycemia in virtual populations of adults, adolescents, and children digressing from two other neuro control approaches. Thus, intelligent systems based on neural networks offer enormous potential for health improvement of T1DM patients. The present contribution illustrates very encouraging results to closed-loop glucose level regulation regarding the autonomous artificial pancreas.