



Blood Glucose-Insulin Dynamics in Type-1 Diabetic Patients for the Mitigation of Hyperglycemic Conditions: A PID Controller with a Step Response

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Abstract. It has been noted that eating habits, physical exercise, and anxiety are some of the elements influencing blood sugar levels. After a diabetic person has eaten, a hyperglycemic condition can be detected right away. In a healthy person, insulin is produced by the pancreatic beta cell, which regulates the body. However, in a diabetic person, the pancreatic beta cell is damaged, making it unable to accomplish normal regulation. The incorporation of a controller to ensure the system operates properly is one of the few solutions to this problem. Bergman's mathematical equations and a PID controller were both used in this investigation, which was conducted in the MATLAB environment. According to the findings, the rising time and settling time for the tuned response were measured at 2.2 and 3.91 s, respectively, while the block response of the controller was measured at 0 and 5.65 s. The derivative gain was adjusted to enhance stability and reduce overshoot.

Keywords: Artificial Pancreas · Diabetes · Glucose · Hyperglycemia · Insulin · PID · Step response

1 Introduction

Modern technological developments enable little human intervention while providing advanced preventive measures and medical supervision [1] to those in need. An organ of the body located next to the stomach called the pancreas makes insulin and fluid to help with food digestion [2]. In essence, food digestion is handled by the exocrine, whereas sugar or glucose control is handled by the endocrine system [3]. A chemical constituent called insulin regulates the amount of glucose in the bloodstream [4]. The body requires sugar, also known as glucose, which is a monosaccharide and a type of carbohydrate, for energy. Its molar mass is 180 g/mol, and its chemical formula is $C_6H_{12}O_6$ mol [5]. According to [6], a healthy patient's overnight fasting glucose level should be between 70 and 180 mg/dl, or 3.9 and 10 mmol/l. The blood glucose concentration rises after a meal, but in healthy patients, it normally returns to fasting