UNIVERSITI TEKNOLOGI MARA

IN-SILICO WORKS ON CONTROL OF BLOOD GLUCOSE LEVEL (BGL) FOR TYPE 1 DIABETES (T1D) USING IMPROVED HOVORKA EQUATIONS AND ENHANCED MODEL PREDICTIVE CONTROL (EMPC)

AMAR BIN MOHD MAAROF

Dissertation submitted in partial fulfillment of the requirements for the degree of **Bachelor of Engineering (Hons.) Chemical**

FACULTY OF CHEMICAL ENGINEERING

JULY 2019

ABSTRACT

Artificial pancreas technology has been continuously developed over the past few years. However, there are still flaws found in recent technology in relation to injection of insulin subcutaneously into type 1 diabetes patient. The injection of insulin into the patient boy must be specific, exact and precise to ensure that the blood glucose level is between the normoglycaemic ranges, 4.5 mmol/L to 6.0 mmol/L. If the blood glucose level (BGL) were below or over normoglycaemic range, patients will experience effects caused by hyperglycemia or hypoglycemia. Therefore, the research seeks to find optimum insulin infusion rate into the patient for the blood glucose level to be at safe glycemic range. The research on development of artificial pancreas is mainly focusing on the algorithm that will be programmed into controller system. This research will use enhanced Model Predictive Controller (eMPC) and improved Hovorka equations for insilico works for controlling blood glucose level for Type 1 Diabetes (T1D). The simulations were ran on MATLAB software. Only meal disturbance factor is include and varies in CHO intake during breakfast, lunch and dinner. Reference data to be substituted into related parameter value in the equation for meal disturbance are taken from real life patient data. The simulation was successfully carried out and the result was observed, evaluated and discussed. The value of insulin administered is at 0.0529 U/min, 0.001 U/min and 0.000001 U/min for breakfast, lunch and dinner respectively. Blood Glucose Level (BGL) observed at each meal time is either at between normoglycaemic ranges or at slight deviation.

ACKNOWLEDGEMENT

In the name of Allah most gracious, most merciful, I am thankful to Allah for giving me this opportunity and His blessing to complete this research project. This research project would not be completed without the guidance, support and contribution from the persons encountered by me during the evaluation of this project.

First of all, I would like to express my appreciation to my supervisor, Prof Madya Dr Ayub Md Som for his continuous encouragement, comment, guidance, support and productive ideas from the beginning until the end of the preparation of this report.

I also would like to thank my beloved families, who have supported and motivated me; no more can best describe my gratitude for their continuous support and contribution and also I would like to forward the same gratitude towards lecturers of Faculty of Chemical Engineering UiTM, friends, and to those who had been directly or indirectly involved in the preparation and accomplishment of this research project.

Last but not least, I also wish to acknowledge and extend their gratitude to the Malaysian Ministry of Higher Education and Institute of Research Management & Innovation (IRMI), Universiti Teknologi MARA (UiTM) for the financial support (600-IRMI/DNA 5/3/BESTARI (060/2017)).

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CHAPTER ONE INTRODUCTION

1.1 Research Background

Diabetes has been a major problem worldwide in terms of prevention, finding cure and controlling the risks associated with having the diseases. It poses serious health issues towards the individual if no proper measures or steps were taken to control the diseases from worsening and contributes to side effects causes by the complications of acquiring diabetes. Up to recent finding, there are three types of diabetes mellitus (diabetes) that already been identified by the world healthcare community; those three are Type 1 Diabetes (T1D), Type 2 Diabetes (T2D) and gestational diabetes. Type 1 Diabetes (T1D) happens when pancreas cannot produce enough insulin hormones to convert blood glucose into energy. Therefore, glucose will likely to build up until it reaches threatening level. To encounter this side effect, T1D patients commonly take insulin injection either subcutaneously or intravenously for the rest of their lives to avoid severe complications that might arise due to having blood glucose level at unusual range. Contrast with T2D patients, Type 2 Diabetes (T2D) occurs when the person pancreas does produce insulin but the body cannot recognize the insulin thus not utilizing it to reduce blood glucose level in the body. In other words, this phenomenon is called insulin resistance. Or it might also happen when the pancreas does not produce enough insulin to reduce the blood glucose level into the normoglycaemic range.

There are also gestational diabetes which normally experienced by pregnant women. Gestational diabetes take place when in pregnancy, the placenta liberates hormones to let the baby grow. The hormones make it difficult for the woman body to produce or put the insulin into use (insulin resistance) in reducing blood glucose level in the woman body. This study will focus on approaches in controlling blood glucose level for T1D patients. T1D is usually diagnosed in teenagers and children before the age of 19 (Jennifer Robinson, 2018). Both genders are equally prone to TID. However, it was found that T1D is more likely to occur to whites ethnic groups compared to other ethnics. According to the World Health Organization, type 1 diabetes is rare in most African,