## 1. Introduction

Diabetes is a chronic disease with a gradual growth apparent through an increase in blood glucose. Diabetes is a disease that makes a poor impact on people's lives around the world. According to the World Health Organization (WHO), around 422 million adults live with diabetes in 2014 globally, up from 108 million in 1980. The rise in diabetes prevalence has a relation with the increasing number of people with the condition. Deaths due to diabetes were approximately 3.7 million in 2012, which included 1.5 million from the disease and 2.2 million from its complications [1].

There are two types of diabetes categorized as type 1 and type 2. Early diagnosis with diabetes can help prevent or minimize its complications. A systematic approach may prevent diabetes, its complications, and hence premature death [1]. Treatment can be ineffective if the disease is too severe.

The cause of each type is different. The root cause of type 1 diabetes is currently unidentifiable despite medical advancement. In other words, there are no cures. Therefore, predictions are made to create awareness and strengthen patients' alertness to the underlying problem. Type 2 diabetes stems from the body's lack of efficacy in the usage of insulin. Diabetes in any shape or form could be detrimental to one's health and quality of life. The probability of this circumstance happening is higher if the disease is left undiagnosed and untreated. The level of blood glucose is a key indicator in probing diabetes. For that reason, the prediction of blood glucose is important to carry out.

Various studies have been carried out to predict blood glucose with machine learning such as [2], [3], [4] including two studies using LSTM by [5] and [6]. Previous findings and this study focused on diabetes type 1, but the results are also applicable to other types of diabetes. The study of blood glucose prediction written by [5] used the LSTM network, which consists of a singular LSTM layer, bi-directional LSTM layer, and several other fully connected layers. The latter study yielded better results compared to the ARIMA and SVR methods with Root Mean Square Error (RMSE) at the value of 21.747. Research for blood glucose prediction written by [6] states that LSTM-NN is superior with an RMSE value of 12.38 compared to autoregressive and LSTM.

The Long Short-Term Memory (LSTM) of the RNN can be used to predict blood glucose. This method is often used to predict other problems [6]. The memory structure of LSTM can capture and store complex data patterns. LSTM enables the neural network to perform tasks that were previously impossible [7]. Although LSTM has good performances in solving time series problems, it faces a problem where it can't access the content of its previous memory cell when its output gate is closed [8]. Convolutional LSTM (conv-LSTM) is a variation of LSTM that can solve the problem [9]. Conv-LSTM is a gate-based memory system that has a connection between the previous memory content and the gate. It allows the gate to access the previous memory content.

The performance of conv-LSTM outperforms the traditional LSTM, CNN-LSTM, and CNN in previous research [9]. In research studies [18], conv-LSTM has had good results compared to other methods in in diabetes classification problems. Therefore conv-LSTM was chosen and applied to predict blood glucose in the continuous glucose monitoring (CGM) time series data in this study.