

EVALUATION OF MEDICAL GRADE INFUSION PUMP PARAMETER USING GAUSSIAN PROCESS REGRESSION

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ABSTRACT

Prediction techniques are extensively used in medical applications and health care devices. The prediction of the infusion flow rate for the required drug dosage and drug concentration in a smart wireless infusion pump is necessary for precise drug flow for the patients. In this paper, the prediction model has been developed to predict the lag time using Gaussian Process Regression (GPR) technique with a squared exponential kernel. Currently, a smart wireless infusion pump is incorporated with its smart drug library. The required parameters such as drug dosage, drug flow rate are utilized as inputs to predict the lag time and to minimize start-up delays using the proposed regression technique. The evaluation of the prediction model is done by the coefficient of determination (R^2), mean absolute error (MAE), and root-mean-squared error (RMSE). These prediction results are verified for predicting lag time for two different carrier flowrates 10 ml/hr and 50 ml/hr. The outcome of the study indicates that the regression model GPR has better prediction accuracy with a mean R^2 of 0.9. Hence, the GPR technique is capable to achieve quick infusion and optimal flow rate with minimized lag time for smart infusion pumps.

Keywords: GPR, start-up delay, prediction, smart drug library.

INTRODUCTION

Significant improvement in the medical field has developed smart medical devices for the health care system and smart drug delivery devices are one among them. Smart infusion pump usage relies on the different categories available. The usage of syringe infusion pump, portable infusion pump, the ambula-tory infusion pump is based on the mechanism adopted for each device [1]. The flow rate of these medical devices is based on pressure variation, motor movements, a revolution of the peristaltic pump and rotary pumps. It can be used for dialysis, chemotherapy, infusion of nutrients, saline, anaesthesia, blood infusion for cardio-related issues [2].

Physiological control systems with medical devices to enable interoperability, network connectivity, safety measures are vital [3]. Currently, the integration of artificial intelligence such as prediction techniques, fuzzy logic, etc., with control system concepts for smart medical devices is gaining popularity [4]. The utilization of smart medical pumps includes drug administration, drug delivery with required concen-tration, pumping of blood, administration of anaesthesia [5].

Research has been handled on the estimation of blood flow rate in blood pumps using the GPR model and the estimation of viscosity, a pressure difference is focused [6]. The drug parameters such as coeffi-cient of viscosity and ambient temperature have an impact on the flow rate in an infusion pump. The analysis has been performed using regression methods [7], [8]. For patients with type I diabetes, a control algorithm for insulin dosage to maintain blood glucose level is carried with a hybrid approach named backstepping sliding mode Gaussian controller [9]. The authors focused on