Design of an Efficient Controller for Arterial Oxygen Saturation in Neonatal Infants

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ABSTARCT

A common problem for premature infants is respiratory distress syndrome (IRDS), also called neonatal respiratory distress syndrome, or respiratory distress syndrome of newborn. Due to IRDS, the infant requires intervention in the form of respiratory support to increase the inspired oxygen. Physicians must keep the range of the Arterial Oxygen Saturation (SpO_2) between 82 – 95% to help the premature infants to get oxygen enough while preventing other complications. If the blood oxygen saturation is more than 95% or less than 82%, the infant is at risk for retinopathy of prematurity. The control is analyzed using PI, PID, Model Predictive Controller (MPC), Robust control wit PID and Robust control with MPC to ensure stability and minimum settling time to reach the accuracy of output SpO_2 by applying the Fraction of Inspired Oxygen (FiO_2) as control action. MPC is an optimal control strategy based on numerical optimization by using a system model and optimizing at regular intervals. We can predict the future control inputs and future plant responses. An error model is created using the resulting ranges of system gains and time constant from [18]. The $\mu - synthesis$ controller is developed to control the oxygen percentage of inspired air and performance specifications are defined. The H_∞ method is used to determine the robust stability and robust performance are achieved with the system uncertainty that described by the error model. A comparison among a static proportional integral, proportional integral derivative, the model predictive controller, the robust controller with PID controller, and the robust controller with MPC found that the robust controller with MPC displays the best performance for a system with large ranges of model parameters.