

MODELING AND CONTROL OF ARTERIAL OXYGEN SATURATION IN PREMATURE INFANTS

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ABSTRACT

In this work modeling and control of neonatal infant's blood oxygen saturation (SpO_2) is investigated. Through analyzing the biological system, it was shown that the blood is oxygenated through the mechanisms of ventilation, perfusion, and diffusion. It was also shown that the fraction of inspired oxygen (FiO_2), heart rate, and respiratory rate had an effect on the oxygenation of the blood. Four different models were used to model the SpO_2 . The models investigated are a neural network, fuzzy logic, updating transfer function, and dynamic transfer function model. The best performing model was the dynamic transfer function model. This model was able to adjust to changes in the infant's biological system and accurately estimate the SpO_2 for a prolonged time. Three different controllers were designed. The controllers are a linear quadratic regulator proportional integral controller, an adaptive controller with feed-forward disturbance rejection, and robust controller. All controllers were designed using the dynamic transfer function model. The controllers were designed to regulate the SpO_2 by adjusting the FiO_2 . Each controller attempted to reject the disturbances caused by the heart rate and respiratory rate. The controllers were tested on simulated data. The best controller was found to be the robust controller with an average SpO_2 of 6.6423e-004% and a maximum SpO_2 value of 0.0725%. The SpO_2 is normalized at 90% and the FiO_2 is normalized at 21%.