Public Abstract

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Title:Control of Arterial Hemoglobin Saturation in Premature Infants using H-infinity Synthesis and Performance Specifications from Best Clinical Practice

This work details the development of a novel control system for regulating the Arterial Hemoglobin saturation (SpO_2) of premature infants. The careful control of SpO_2 through regulating the fraction of inspired Oxygen (FiO_2) is vital to the infants' health. The SpO_2 must remain above 85% to avoid hypoxia, which can cause tissue damage or death, and below 92% to avoid Retinopathy of Prematurity, which causes retinal damage and blindness. An H-infinity synthesis method was used to derive a system of controllers, which regulate the FiO_2 . Multiple controllers were needed for robust control due to the large range of parametric uncertainty in the model. In order to switch between controllers and adapt to the changing physiology of the patients a genetic algorithm was modified and tested. This algorithm was proven to adequately track changing model parameters, avoid local minimums, and select an appropriate robust controller for providing closed loop control. Performance specifications for the controllers were defined using manual control protocols that were clinically proven to reduce the rate of Retinopathy of Prematurity (ROP) in the target patients. The controllers were tested using previously validated models and shown to meet the robust stability and performance specifications. In addition a physical prototype was designed and built to facilitate automatic control of FiO_2 while minimizing risk to the patient during clinical tests of the control algorithms.