

# Rancang Bangun Sistem Embedded Pengukuran Konsentrasi Hemoglobin Noninvasif deng = Design and Development of an Embedded System for Non Invasive Hemoglobin Concentration Measurement Using Machine Learning Method Based on Nvidia Jetson Nano

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## Abstrak

Hemoglobin adalah komponen darah yang penting untuk mengikat oksigen di paru paru dan mendistribusikannya ke seluruh tubuh. Metode invasif tidak memungkinkan pengukuran real-time dalam situasi darurat. Pengembangan metode noninvasif untuk pemeriksaan hemoglobin menghadapi tantangan dalam hal akurasi, ketepatan, dan keringkasan alat. Pada penelitian menggunakan sensor MAX30102 sebagai pembaca gelombang merah dan inframerah, OLED sebagai alat yang menampilkan hasil prediksi, dan Nvidia Jetson Nano sebagai processor. Alat juga dilengkapi dengan pembacaan detak jantung, SpO2, dan dua tombol untuk mengulang pembacaan dan mematikan alat. Pelatihan model dilakukan menggunakan dataset yang diperoleh dari riset sebelumnya, "Pengembangan Instrumentasi Pengukur Konsentrasi Hemoglobin Non-Invasif Berbasis Photoplethysmography dan Machine Learning" oleh Ester Vinia (2023). Setelah melakukan pelatihan pada lima jenis model (Dense Neural Network, Decision Tree, Support Vector, Gradient Boosting, dan Random Forest), didapatkan model dengan metode Dense Neural Network memiliki akurasi R2 sebesar 96%, loss MAE sebesar 0,2 dan MSE sebesar 0,11, metode Decision Tree memiliki akurasi R2 sebesar 90%, loss MAE sebesar 0,27 dan MSE sebesar 0,3, metode Support Vector memiliki akurasi R2 sebesar 17%, loss MAE sebesar 1,2 dan MSE sebesar 2,61, metode Gradient Boosting memiliki akurasi R2 sebesar 89%, loss MAE sebesar 0,43 dan MSE sebesar 0,3, dan metode Random Forest memiliki akurasi R2 sebesar 99%, loss MAE sebesar 0,05 dan MSE sebesar 0,02. Prototipe alat kemudian dibuat menggunakan pembelajaran mesin bermodel Random Forest Regressor. Model kemudian ditanam di Nvidia Jetson Nano sehingga alat dapat dioperasikan dengan efisien dan cepat. Pada pengujian alat, didapatkan nilai akurasi sebesar 93,27%.

.....Hemoglobin is a vital blood component responsible for binding oxygen in the lungs and distributing it throughout the body. Invasive methods do not allow real-time measurement in emergency situations. Developing noninvasive methods for hemoglobin examination faces challenges in accuracy, precision, and device compactness. In this research, a MAX30102 sensor was used for reading red and infrared waves, an OLED for displaying prediction results, and an Nvidia Jetson Nano as the processor. The device also includes heart rate and SpO2 readings, and two buttons for repeating readings and turning off the device. The model was trained using a dataset obtained from previous research, "Development of Non Invasive Hemoglobin Concentration Measurement Instrumentation Based on Photoplethysmography and Machine Learning" by Ester Vinia (2023). After training on five types of models (Dense Neural Network, Decision Tree, Support Vector, Gradient Boosting, and Random Forest), the Dense Neural Network model achieved an R2 accuracy of 96%, MAE loss of 0.2, and MSE loss of 0.11; the Decision Tree method achieved an R2 accuracy of 90%, MAE loss of 0.27, and MSE loss of 0.3; the Support Vector method achieved an R2 accuracy of 17%, MAE loss of 1.2, and MSE loss of 2.61; the Gradient Boosting method achieved an R2

accuracy of 89%, MAE loss of 0.43, and MSE loss of 0.3; and the Random Forest method achieved an R2 accuracy of 99%, MAE loss of 0.05, and MSE loss of 0.02. The device prototype was then developed using the Random Forest Regressor model. The model was embedded in the Nvidia Jetson Nano, allowing the device to operate efficiently and quickly. During testing, the device achieved an accuracy of 93.27%.