Pengembangan Metode Pengukuran Laju Pernapasan Bayi Non-Kontak Berbasis Video Menggunakan Deteksi ROI Otomatis dan Analisis Optical flow = Development of a Non-Contact Video-Based for Measurement of Infant Respiratory Rate using Automatic ROI Detection and Optical Flow Analysis

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Abstrak

Pengukuran laju pernapasan bayi secara non-kontak menawarkan alternatif inovatif dibandingkan dengan metode konvensional berbasis kontak yang sering kali menyebabkan ketidaknyamanan. Penelitian ini bertujuan untuk mengembangkan metode otomatis yang dapat mendeteksi Region of Interest (ROI) pada tubuh bayi dan menghitung laju pernapasan menggunakan analisis optical flow. Pendekatan ini dirancang untuk mendukung pemantauan bayi dengan penyakit jantung bawaan, yang memerlukan pemantauan rutin terhadap laju pernapasan sebagai indikator kondisi kesehatan mereka. Sistem yang diusulkan memanfaatkan model MediaPipe Pose untuk mendeteksi ROI secara otomatis. Pergerakan dalam ROI dianalisis menggunakan optical flow yang dikombinasikan dengan beberapa filter yaitu Hampel Filter, Moving Average Filter, dan Bandpass Filter. Laju pernapasan diestimasi melalui deteksi puncak dengan parameter tanpa jarak, 1 detik, 1,5 detik, dan 2 detik, serta analisis Fast Fourier Transform (FFT). Pengujian dilakukan pada dataset video AIR-125 yang mencakup berbagai kondisi pencahayaan, pose bayi, resolusi dan frame rate. Hasil pengujian menunjukkan bahwa pendekatan ini mampu mendeteksi ROI pada area torso tubuh bayi serta mengestimasi laju pernapasan dengan kesalahan Mean Absolute Error (MAE) sebesar 3,26 BPM, Root Mean Square Error (RMSE) sebesar 4,87 BPM, dan Limits of Agreement antara -10 BPM hingga 8,97 BPM untuk deteksi puncak dengan parameter jarak 1,5 detik. Untuk estimasi berbasis FFT, MAE tercatat sebesar 4,54 BPM, RMSE sebesar 6,60 BPM, dan Limits of Agreement antara -12,84 BPM hingga 12,95 BPM. Sistem ini menawarkan solusi non-kontak yang fleksibel, mudah diadaptasi, dan relevan untuk pemantauan bayi di rumah sakit maupun dalam pengaturan rawat jalan di rumah, khususnya bagi bayi dengan penyakit jantung bawaan yang memerlukan pengawasan intensif.

.....Measuring the respiratory rate of infants non-contact offers an innovative alternative compared to conventional contact-based methods, which often cause discomfort. This research aims to develop an automatic method that can detect the Region of Interest (ROI) on the infant's body and calculate the respiratory rate using optical flow analysis. This approach is designed to support the monitoring of infants with congenital heart disease, who require routine monitoring of their respiratory rate as an indicator of their health condition. The proposed system utilizes the MediaPipe Pose model to automatically detect the ROI. Movement within the ROI is analyzed using optical flow combined with several filters, namely the Hampel Filter, Moving Average Filter, and Bandpass Filter. The respiratory rate is estimated through peak detection with distance parameters of none, 1 second, 1.5 seconds, and 2 seconds, as well as Fast Fourier Transform (FFT) analysis. Testing was conducted on the AIR-125 video dataset, which includes various lighting conditions, infant poses, resolutions, and frame rates. The test results show that this approach is capable of detecting the ROI in the torso area of the infant and estimating the respiratory rate with a Mean Absolute Error (MAE) of 3.26 BPM, Root Mean Square Error (RMSE) of 4.87 BPM, and the Limits of Agreement

were -10 to 8.97 BPM for peak detection with a distance parameter of 1.5 seconds. For FFT-based estimation, the MAE recorded was 4.54 BPM, RMSE was 6.60 BPM, and the Limits of Agreement were -12.84 to 12.95 BPM. This system offers a flexible, easily adaptable, and relevant non-contact solution for monitoring infants in hospitals as well as in outpatient settings at home, particularly for infants with congenital heart disease who require intensive supervision.