

## ABSTRAK

Alfi Nur Zeha

ANALISIS PENGGUNAAN FILTER *INFINITE IMPULSE RESPONSE* (IIR) UNTUK MEREDUKSI NOISE PADA SISTEM *WEB-BASED VITAL SIGN MONITOR (SPO2 SIGNAL)*

xviii + 75 Halaman + 7 Tabel + 13 Lampiran

Skrining SpO<sub>2</sub> merupakan salah satu parameter penting dalam pemantauan tanda-tanda vital, terutama pada sistem vital sign monitor berbasis Internet of Things (IoT) yang memungkinkan pemantauan secara real-time dan jarak jauh. Namun, akurasi pembacaan SpO<sub>2</sub> sering dipengaruhi oleh kualitas sinyal photoplethysmograph (PPG) yang rentan terhadap berbagai gangguan eksternal. Motion artifact akibat gerakan jari merupakan salah satu faktor utama yang mengganggu kestabilan sinyal PPG pada sistem monitoring SpO<sub>2</sub>. Penelitian ini bertujuan untuk menganalisis pengaruh penggunaan filter digital Infinite Impulse Response (IIR) jenis Butterworth dan Elliptic dalam mereduksi noise artefak gerakan pada sinyal SpO<sub>2</sub>. Sinyal dikumpulkan dari 10 responden dalam kondisi bersih, terpapar noise, dan setelah dilakukan filtering digital menggunakan mikrokontroler Arduino Nano. Data yang diperoleh dianalisis menggunakan Fast Fourier Transform (FFT), Power Spectral Density (PSD), serta perhitungan Signal-to-Noise Ratio (SNR). Hasil menunjukkan bahwa noise akibat gerakan menyebabkan penyebaran spektrum di atas 3 Hz dan perubahan amplitudo sinyal. Filter lowpass digital dengan cutoff 3 Hz mampu menekan sebagian noise frekuensi tinggi, namun efektivitasnya bervariasi antar responden. Filter Butterworth memberikan hasil spektrum yang lebih halus, sementara Elliptic lebih agresif namun berpotensi menimbulkan ripple. Analisis SNR berbasis FFT dan PSD menunjukkan bahwa hanya sebagian responden yang mengalami peningkatan SNR, sedangkan pada beberapa responden lainnya, nilai SNR justru menurun setelah filtering. Rata-rata delta SNR yang diperoleh dari metode FFT untuk filter Butterworth adalah sebesar +0.905 dB, dan untuk filter Elliptic sebesar +0.899 dB, sedangkan pada metode PSD, rata-rata delta SNR Butterworth adalah +0.98 dB dan Elliptic +0.66 dB. Hasil ini menunjukkan bahwa filter digital IIR dapat membantu mereduksi noise artefak gerakan pada sinyal SpO<sub>2</sub>, namun peningkatan kualitas sinyal tidak terjadi secara merata. Variasi efektivitas dipengaruhi oleh karakteristik noise yang tidak seragam antar individu.

Kata kunci: SpO<sub>2</sub>, motion artifact, filter IIR, Butterworth, Elliptic, FFT, PSD, SNR.  
Daftar bacaan: 1 buku (2022), 36 jurnal (2015 - 2024)

## ABSTRACT

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ANALYSIS OF THE USE OF INFINITE IMPULSE RESPONSE (IIR) FILTERS TO REDUCE NOISE IN A WEB-BASED VITAL SIGN MONITOR (SPO<sub>2</sub> SIGNAL) SYSTEM

xviii + 75 Pages + 7 Tables + 13 Appendices

*SpO<sub>2</sub> is one of the important parameters in vital sign monitoring, especially in Internet of Things (IoT)-based vital sign monitoring systems that allow real-time and remote monitoring. However, the accuracy of SpO<sub>2</sub> readings is often affected by the quality of the photoplethysmograph (PPG) signal which is susceptible to various external interferences. Motion artifacts due to finger movements are one of the main factors that interfere with the stability of the PPG signal in the SpO<sub>2</sub> monitoring system. This study aims to analyze the effect of the use of Butterworth and Elliptic types Infinite Impulse Response (IIR) digital filters in reducing motion artifact noise on SpO<sub>2</sub> signals. Signals were collected from 10 respondents in clean conditions, exposed to noise, and after digital filtering using an Arduino Nano microcontroller. The data obtained was analyzed using Fast Fourier Transform (FFT), Power Spectral Density (PSD), and Signal-to-Noise Ratio (SNR) calculations. The results showed that noise due to movement led to a spectrum spread above 3 Hz and a change in signal amplitude. Digital lowpass filters with a 3 Hz cutoff are able to suppress some high-frequency noise, but their effectiveness varies between respondents. The Butterworth filter provides smoother spectrum results, while the Elliptic is more aggressive but has the potential to cause ripples. The analysis of SNR based on FFT and PSD showed that only some respondents experienced an increase in SNR, while in some other respondents, SNR values actually decreased after filtering. The average delta SNR obtained from the FFT method for the Butterworth filter is +0.905 dB, and for the Elliptic filter is +0.899 dB, while in the PSD method, the average delta SNR of Butterworth is +0.98 dB and the Elliptic is +0.66 dB. These results suggest that IIR digital filters can help reduce motion artifact noise in SpO<sub>2</sub> signals, but signal quality improvements do not occur evenly. Variations in effectiveness are influenced by noise characteristics that are not uniform between individuals.*

*Keywords: SpO<sub>2</sub>, motion artifact, IIR filter, Butterworth, Elliptic, FFT, PSD, SNR.*

*References: 1 books (2022), 36 journals (2015 - 2024)*