

ABSTRAK

Salma Syahidah Nurromadhona

ANALISIS EFEKTIVITAS KOMBINASI FILTER DIGITAL BUTTERWORTH-UNANR DALAM MEREDUKSI INTERFERENSI ELEKTROMAGNETIK (EMI) PADA SINYAL ECG 12 CHANNEL (LIMB LEADS)

xviii + 164 Halaman + 12 Tabel + 7 Lampiran

Elektrokardiogram (ECG) merupakan alat diagnostik jantung yang penting dalam dunia medis, namun sering mengalami interferensi elektromagnetik (EMI) baik melalui kelistrikan maupun lingkungan. Interferensi tersebut dapat menyebabkan distorsi pada gelombang asli seperti P, QRS, dan T sehingga menyulitkan identifikasi fitur penting ECG, menurunkan akurasi perekaman, dan berpotensi menyebabkan kesalahan diagnosis. Penelitian ini bertujuan mengembangkan metode optimal untuk mereduksi EMI pada sinyal ECG 12-lead dengan mengombinasikan filter digital Butterworth dan *Unbiased and Normalized Adaptive Noise Reduction* (UNANR). Kombinasi ini secara efektif mereduksi EMI tanpa menghilangkan dan mengubah bentuk sinyal ECG. Filter Butterworth digunakan untuk menyaring *noise* frekuensi tinggi, sementara UNANR digunakan secara adaptif untuk mengurangi distorsi sinyal. Penelitian dilakukan dengan merekam sinyal ECG menggunakan modul ADS1293 CJMCU dan mikrokontroler STM32 Nucleo-64 F446RE, serta menganalisis data menggunakan *fast fourier transform* (FFT) dan *signal-to-noise ratio* (SNR). Filter Butterworth diuji pada orde 2, 4, 6, dan 8 dengan rentang frekuensi 0.5–100 Hz, kemudian hasil orde terbaik dikombinasikan dengan UNANR. Hasil menunjukkan bahwa kombinasi filter Butterworth orde 8 dan UNANR meningkatkan SNR dari 33.4 dB hingga 78.09 dB menjadi 34.11 dB hingga 78.68 dB dengan penekanan terbesar 4.5 dB pada Lead aVF. Kesimpulannya, metode ini efektif mereduksi EMI tanpa mengubah bentuk sinyal ECG. Penelitian ini berimplikasi pada peningkatan akurasi perekaman ECG dan pengembangan perangkat elektrokardiografi yang bebas distorsi EMI listrik maupun lingkungan. Kontribusi utama penelitian ini meliputi pendekatan baru dalam *filtering* sinyal ECG 12 *channel* menggunakan metode kombinasi dua filter, penyediaan bukti kuantitatif berbasis SNR terhadap efektivitas metode kombinasi, referensi praktis untuk pengembangan alat ECG bebas gangguan EMI, serta rekomendasi filter optimal yang dapat digunakan dalam pereduksian interferensi elektromagnetik pada sinyal biomedis.

Kata kunci: ECG, butterworth, UNANR, interferensi elektromagnetik, SNR

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ABSTRACT

Salma Syahidah Nurromadhona

ANALYSIS OF THE EFFECTIVENESS OF BUTTERWORTH-UNANR DIGITAL FILTER COMBINATION IN REDUCING ELECTROMAGNETIC INTERFERENCE (EMI) IN 12 CHANNEL ECG SIGNAL (LIMB LEADS)

xviii + 164 Pages + 12 Tables + 7 Appendices

Electrocardiogram (ECG) is an important cardiac diagnostic tool in the medical world, but it often experiences electromagnetic interference (EMI) both through electricity and the environment. This interference can cause distortion in the original waves such as P, QRS, and T, making it difficult to identify important ECG features, reducing recording accuracy, and potentially causing misdiagnosis. This study aims to develop an optimal method to reduce EMI in 12-lead ECG signals by combining Butterworth digital filters and Unbiased and Normalized Adaptive Noise Reduction (UNANR). This combination effectively reduces EMI without eliminating and changing the shape of the ECG signal. Butterworth filters are used to filter high-frequency noise, while UNANR is used adaptively to reduce signal distortion. The study was conducted by recording ECG signals using the ADS1293 CJMCU module and the STM32 Nucleo-64 F446RE microcontroller, and analyzing the data using fast fourier transform (FFT) and signal-to-noise ratio (SNR). Butterworth filters were tested at 2nd, 4th, 6th, and 8th orders with a frequency range of 0.5–100 Hz, then the best order results were combined with UNANR. The results showed that the combination of 8th order Butterworth filters and UNANR increased the SNR from 33.4 dB to 78.09 dB to 34.11 dB to 78.68 dB with the greatest suppression of 4.5 dB in Lead aVF. In conclusion, this method is effective in reducing EMI without changing the shape of the ECG signal. This study has implications for improving the accuracy of ECG recording and the development of electrocardiography devices that are free from electrical and environmental EMI distortion. The main contributions of this study include a new approach in filtering 12-channel ECG signals using a combination method of two filters, providing quantitative evidence based on SNR on the effectiveness of the combination method, practical references for the development of ECG devices free from EMI interference, and recommendations for optimal filters that can be used in reducing electromagnetic interference on biomedical signals.

Keywords: ECG, butterworth, UNANR, electromagnetic interference, SNR.

References: 65 Journals (2015-2025)