ABSTRAK

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RANCANG BANGUN HOLTER MONITOR DENGAN INDIKASI *TACHYCARDIA* DAN *BRADYCARDIA* TAMPIL LCD NEXTION (PENYIMPANAN DATA)
xviii + 92 Halaman + 45 Gambar + 13 Tabel + 2 Lampiran

Gangguan irama jantung seperti bradikardia (denyut jantung di bawah 60 bpm) dan takikardia (denyut jantung di atas 100 bpm) berpotensi menimbulkan risiko serius jika tidak terdeteksi sejak dini. Namun, ketersediaan alat pemantauan jantung masih terbatas di rumah sakit, bersifat tidak portabel, dan memerlukan biaya tinggi. Berdasarkan hal tersebut, penelitian ini bertujuan merancang dan mengembangkan sistem Holter Monitor berbasis mikrokontroler ESP32 yang dapat mendeteksi dan menampilkan kondisi irama jantung secara *real-time* melalui LCD Nextion, sekaligus menyimpan data hasil pemantauan ke SD Card dalam format CSV sebagai rekam medis. Sistem ini menggunakan konfigurasi sadapan *Lead* II dengan tiga elektroda (RA, LL, RL) untuk menangkap sinyal ECG yang kemudian diproses melalui rangkaian analog meliputi *instrumentation amplifier, high pass filter, low pass filter, notch filter, non-inverting amplifier,* dan *adder*, sehingga sinyal yang masuk ke ESP32 lebih bersih dan terukur. Penelitian menggunakan metode pra-eksperimental dengan pendekatan *after only design*, di mana performa alat dinilai setelah implementasi. Sistem dilengkapi metode deteksi puncak sinyal untuk menghitung BPM, klasifikasi kondisi jantung (normal, bradikardia, atau takikardia), serta mekanisme buffer ganda guna memastikan akurasi penyimpanan data tanpa kehilangan informasi. Hasil uji coba dengan alat pembanding Phantom ECG menunjukkan sistem mampu menampilkan BPM dengan error sangat rendah, berkisar 0% hingga 0,4%, jauh di bawah ambang batas toleransi 5%. Uji coba pada responden menggunakan *Pulse Oxymeter* menghasilkan nilai error antara 0,2% hingga 1,5%, sehingga menunjukkan tingkat akurasi yang tinggi. Selain menampilkan notifikasi kondisi jantung secara otomatis, sistem juga menyimpan data ke SD Card dengan jumlah 742 sampel selama 3 menit. Walaupun terdapat variasi kecil pada amplitudo antar titik akibat perbedaan jumlah data dan rentang skala, pola sinyal ECG tetap konsisten dan puncak gelombang R dapat terdeteksi dengan jelas. Format CSV yang digunakan mendukung analisis lanjutan secara *offline*, baik untuk visualisasi grafik maupun pengolahan data medis. Dengan demikian, Holter Monitor ini terbukti berfungsi sesuai tujuan, efisien, portabel, serta hemat biaya, dan memiliki potensi besar untuk digunakan dalam pemantauan jantung secara luas di luar lingkungan klinis. Kontribusi utama penelitian ini adalah terciptanya alat monitoring berbasis mikrokontroler dengan deteksi *real-time*, tampilan visual, serta penyimpanan data yang akurat, sekaligus mendukung perkembangan layanan kesehatan berbasis teknologi.

Kata Kunci: Holter Monitor, ECG, SD Card, LCD Nextion, Takikardia, Bradikardia, ESP32
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ABSTRACT

Wanda Nuril Habiba
DESIGN AND DEVELOPMENT OF A HOLTER MONITOR WITH TACHYCARDIA AND BRADYCARDIA INDICATION DISPLAYED ON NEXTION LCD (DATA STORAGE)
xviii + 92 *Pages* + 45 *Pictures* + 13 *Tables* + 2 *Appendices*

Heart rhythm disorders such as bradycardia (heart rate below 60 bpm) and tachycardia (heart rate above 100 bpm) can pose serious risks if not detected early. However, the availability of heart monitoring devices is still limited to hospitals, where they are non-portable and costly. Based on this background, this study aims to design and develop a Holter Monitor system based on the ESP32 microcontroller, capable of detecting and displaying heart rhythm conditions in real-time through a Nextion LCD, while also storing monitoring data onto an SD Card in CSV format as medical records. The system uses a Lead II configuration with three electrodes (RA, LL, RL) to capture ECG signals, which are then processed through analog circuits including an instrumentation amplifier, high-pass filter, low-pass filter, notch filter, non-inverting amplifier, and adder, ensuring that the signals entering the ESP32 are cleaner and more measurable. The research employed a pre-experimental method with an "after-only design" approach, in which the system's performance was evaluated after implementation. The system is equipped with a peak detection method to calculate BPM, classify heart conditions (normal, bradycardia, or tachycardia), and a double buffering mechanism to ensure accurate data storage without loss. Testing with a Phantom ECG comparison device showed that the system was able to display BPM with very low error rates, ranging from 0% to 0.4%, far below the 5% tolerance threshold. Trials on respondents using a Pulse Oximeter comparison device produced error values between 0.2% and 1.5%, indicating high accuracy. In addition to automatically displaying heart condition notifications, the system also stored 742 samples of data within 3 minutes on the SD Card. Although there were slight variations in amplitude across points due to differences in data quantity and scale range, the ECG signal pattern remained consistent and the R-wave peak was clearly detected. The CSV format used supports further offline analysis, whether for graphical visualization or medical data processing. Thus, the Holter Monitor proved to function as intended, being efficient, portable, and cost-effective, with significant potential for widespread use in heart monitoring outside clinical settings. The main contribution of this research is the creation of a microcontroller-based heart monitoring device with real-time detection, visual display, and accurate data storage, supporting the advancement of technology-based healthcare services.

Keywords: Holter Monitor, ECG, SD Card, Nextion LCD, Tachycardia, Bradycardia, ESP32
References: 18 Journals (2017-2024)