DETEKSI ARITMIA JANTUNG BERBASIS INTEGRASI SINYAL ECG DAN PPG DENGAN PENDEKATAN *MACHINE LEARNING* DAN *DEEP LEARNING* DALAM SISTEM IOT

SKRIPSI

Diajukan untuk memenuhi salah satu syarat untuk memperoleh gelar Sarjana Teknik di Program Studi Mekatronika dan Kecerdasan Buatan

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ABSTRAK

Aritmia adalah gangguan irama jantung yang dapat memicu komplikasi serius seperti stroke dan gagal jantung bila tidak terdeteksi dini. Perangkat pemantauan konvensional masih terbatas dari sisi portabilitas dan akses, khususnya di daerah dengan fasilitas kesehatan minim. Penelitian ini bertujuan merancang sistem pemantauan kesehatan jantung berbasis integrasi sinyal ECG dan PPG dengan machine learning untuk deteksi aritmia real-time di luar klinis. Metode menggunakan pendekatan Research and Development (R&D) dengan model ADDIE. Sistem dibangun pada mikrokontroler ESP32 yang terhubung dengan sensor ECG (AD8232) dan PPG (MAX30102), mengirim data ke *Firebase Realtime Database* dan menampilkannya di dashboard web. Proses meliputi filtering, segmentasi, normalisasi, serta ekstraksi fitur seperti RR interval, Heart Rate, SDNN, dan RMSSD, kemudian diklasifikasikan dengan CNN, SVM, dan LightGBM. Hasilnya, LightGBM unggul dengan akurasi 95,35%, sensitivitas 96,43%, dan spesifisitas 93,33%. Sistem ini akurat, portabel, dan potensial untuk skrining dini aritmia di masyarakat dengan akses medis terbatas.

Kata Kunci: Aritmia, ECG, PPG, Internet of Things, CNN, SVM, LightGBM

Heart Arrhythmia Detection Based on ECG and PPG Signal Integration Using Machine learning and Deep Learning Approaches in an IoT System

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ABSTARCT

Arrhythmia is a heart rhythm disorder that can trigger serious complications such as stroke and heart failure if not detected early. Conventional monitoring devices are still limited in terms of portability and access, especially in areas with minimal health facilities. This study aims to design a heart health monitoring system based on the integration of ECG and PPG signals with machine learning for real-time arrhythmia detection outside of clinics. The method uses a Research and Development (R&D) approach with the ADDIE model. The system is built on an ESP32 microcontroller connected to ECG (AD8232) and PPG (MAX30102) sensors, sending data to the Firebase Realtime Database and displaying it on a web dashboard. The process includes filtering, segmentation, normalization, and feature extraction such as RR interval, Heart Rate, SDNN, and RMSSD, which are then classified using CNN, SVM, and LightGBM. As a result, LightGBM excelled with an accuracy of 95.35%, sensitivity of 96.43%, and specificity of 93.33%. This system is accurate, portable, and has the potential for early screening of arrhythmia in communities with limited medical access.

***Keywords**: Arrhythmia, ECG, PPG, Internet of Things, CNN, SVM, LightGBM*

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DAFTAR GAMBAR

DAFTAR TABEL

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