

INTISARI

ANALISIS DAN IMPLEMENTASI VERIFIKASI BIOMETRIK BERBASIS *HEART RATE VARIABILITY* DARI SINYAL *PHOTOPLETHYSMOGRAPHY* MENGGUNAKAN *ONE-CLASS SUPPORT VECTOR MACHINE*

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Sistem autentikasi biometrik tunggal memiliki keterbatasan dalam hal keseimbangan antara keamanan dan kenyamanan. Penelitian ini mengatasi masalah tersebut dengan merancang sistem keamanan *two layer* biometrik yang mengintegrasikan sensor sidik jari (AS608) dan *Heart Rate Variability* (HRV) dari sinyal *photoplethysmography* (PPG). Sistem diimplementasikan pada purwarupa berbasis ESP32.

Tiga strategi fusi sekuensial (1:1), berbasis skor, dan sekuensial hirarkis dievaluasi secara komparatif pada 5 subjek penelitian. Fitur HRV yang mencakup domain waktu, frekuensi, dan statistik orde tinggi diekstraksi untuk melatih model. Kinerja setiap arsitektur diukur secara kuantitatif menggunakan metrik *False Acceptance Rate* (FAR) dan *False Rejection Rate* (FRR).

Hasil penelitian menunjukkan arsitektur fusi hirarkis sebagai solusi paling superior. Dengan menugaskan sidik jari sebagai pengidentifikasi primer dan HRV (memfungsikan One-Class SVM) sebagai verifikasi anomali sekunder, sistem ini berhasil mencapai tingkat keamanan ideal (FAR 0%) dengan kenyamanan pengguna yang sangat tinggi (FRR rata-rata 14%). Temuan ini membuktikan bahwa HRV sangat efektif sebagai lapisan verifikasi fisiologis untuk memperkuat modalitas primer, serta mendemonstrasikan kelayakan teknis sistem keamanan *two layer* biometrik yang andal pada platform berbiaya rendah.

Kata kunci: autentikasi *two layer* biometrik, fusi biometrik, *Heart Rate Variability* (HRV), sidik jari, One-Class SVM.

ABSTRACT

ANALYSIS AND IMPLEMENTATION OF HEART RATE VARIABILITY BASED BIOMETRIC VERIFICATION FROM PHOTOPLETHYSMOGRAPHY SIGNALS USING A ONE-CLASS SUPPORT VECTOR MACHINE

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Single-modality biometric authentication systems have limitations in balancing security and convenience. This research addresses this issue by designing a multimodal biometric security system that integrates a fingerprint sensor (AS608) and Heart Rate Variability (HRV) derived from photoplethysmography (PPG) signals. The system is implemented on an ESP32-based prototype.

Three fusion strategies—sequential (1:1 logic), score-level, and hierarchical—were comparatively evaluated on 5 research subjects. HRV features spanning time-domain, frequency-domain, and higher-order statistics were extracted to train the models. The performance of each architecture was quantitatively measured using False Acceptance Rate (FAR) and False Rejection Rate (FRR) metrics.

The research findings show the hierarchical fusion architecture as the most superior solution. By assigning the fingerprint as the primary identifier and HRV (using a One-Class SVM) as a secondary anomaly verifier, the system successfully achieved an ideal security level (0% FAR) with very high user convenience (an average FRR of 14%). This finding proves that HRV is highly effective as a physiological verification layer to reinforce the primary modality and demonstrates the technical feasibility of a reliable multimodal biometric security system.

Keywords: *multimodal biometric authentication, biometric fusion, Heart Rate Variability (HRV), fingerprint, One-Class SVM, security.*