

ABSTRAK

PERANCANGAN SISTEM CHATBOT MEDIS BERBASIS PENDEKATAN *HYBRID MACHINE LEARNING* UNTUK MENINGKATKAN LAYANAN INFORMASI KLINIK

(2026:XV + 149 halaman + 84 gambar + 18 tabel + 12 lampiran)

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Penelitian ini bertujuan untuk merancang dan mengimplementasikan sistem *chatbot* medis berbasis web guna mengatasi keterbatasan layanan informasi Klinik Opina yang masih bergantung pada respons manual petugas, dengan mengembangkan pendekatan *Hybrid* yang mengintegrasikan *Support Vector Machine* (SVM) sebagai komponen klasifikasi *intent* dan *Large Language Model* (LLM) sebagai penyusun respons akhir yang komunikatif. Sistem dibangun menggunakan *dataset* 3.674 sampel dari 73 kelas *intent* (39 layanan klinik dan 34 penyakit umum), melalui tahap *Preprocessing* berupa normalisasi singkatan, *case folding*, tokenisasi, *stopword removal*, dan *stemming* Sastrawi, serta ekstraksi fitur kombinasi TF-IDF *Word N-gram* (1,2) dan *Character N-gram* (3,4) dengan seleksi Chi-Squared persentil 80%, kemudian diklasifikasikan menggunakan *ensemble* tiga model LinearSVC ($C = 1,5; 3,0; 5,0$) dengan mekanisme *soft voting* dan augmentasi data *training* melalui *synonym replacement*, *random deletion*, dan *word swap*; sistem diintegrasikan dengan Meta Llama 3.1 8B Instruct via NVIDIA API dan di-deploy sebagai aplikasi web *Single Page Application* (SPA) berbasis Flask di klinikOpinapalembang.com. Hasil evaluasi menunjukkan *accuracy* 91,43%, *F1-Score Weighted* 91,57%, *Cohen's Kappa* 0,9128, dan *ROC-AUC Macro* 0,9981 pada 735 sampel *testing*, dengan kestabilan dikonfirmasi melalui *Stratified 5-Fold Cross validation* ($\sigma \approx 0,013$); *McNemar's Test* menunjukkan SVM *Ensemble* berbeda signifikan terhadap *Complement Naive Bayes* dan *Decision Tree* ($p < 0,01$), namun setara dengan *Logistic Regression* ($p = 0,280$) dan *Single SVM* ($p = 0,500$), sementara pengujian fungsional *black-box testing* pada 32 skenario menghasilkan *pass rate* 100% dengan rata-rata *response time* komputasi internal 78,06 ms (persentil ke-95 sebesar 117,25 ms) dan *response time* kondisi penggunaan nyata pada rentang 1,2–2,6 detik.

Kata Kunci: *Chatbot, SVM Ensemble, Large Language Model, Hybrid Machine Learning, Klasifikasi Intent, Natural Language Processing*

ABSTRACT

DESIGN OF A MEDICAL CHATBOT SYSTEM BASED ON A *HYBRID MACHINE LEARNING* APPROACH TO IMPROVE CLINIC INFORMATION SERVICES

(2026: XV + 149 pages + 84 figures + 18 tables + 12 appendices)

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This research aims to design and implement a web-based medical chatbot system to address the limitations of Klinik Opina information services, which still rely on manual responses from staff, by developing a Hybrid approach that integrates Support Vector Machine (SVM) as the intent classification component and a Large Language Model (LLM) as the final communicative response generator. The system was built using a dataset of 3,674 samples across 73 intent classes (39 clinic services and 34 common diseases), through a preprocessing stage consisting of abbreviation normalization, case folding, tokenization, stopword removal, and Sastrawi stemming, as well as combined feature extraction using TF-IDF Word N-gram (1,2) and Character N-gram (3,4) with Chi-Squared percentile selection at 80%, which were then classified using an ensemble of three LinearSVC models ($C = 1.5; 3.0; 5.0$) with a soft voting mechanism and training data augmentation through synonym replacement, random deletion, and word swap; the system was integrated with Meta Llama 3.1 8B Instruct via the NVIDIA API and deployed as a Flask-based Single Page Application (SPA) web application at klinikOpinapalembang.com. The evaluation results show an accuracy of 91.43%, a weighted F1-Score of 91.57%, a Cohen's Kappa of 0.9128, and a macro ROC-AUC of 0.9981 on 735 testing samples, with stability confirmed through Stratified 5-Fold Cross validation ($\sigma \approx 0.013$); McNemar's Test showed that the SVM Ensemble differed significantly from Complement Naive Bayes and Decision Tree ($p < 0.01$), but was statistically equivalent to Logistic Regression ($p = 0.280$) and Single SVM ($p = 0.500$), while functional black-box testing on 32 scenarios resulted in a 100% pass rate with an average internal computation response time of 78.06 ms (95th percentile of 117.25 ms) and a real-world usage response time ranging from 1.2–2.6 seconds.

Kata Kunci: *Chatbot, SVM Ensemble, Large Language Model, Hybrid Machine Learning, Intent Classification, Natural Language Processing*