Perancangan Sistem Pendeteksi Kebohongan Pada Wawancara Warga Negara Indonesia Berbasis Machine Learning dengan Multi-Feature Facial Analysis untuk Aplikasi Imigrasi = The Design of a Machine Learning-Based Lie Detection System for Immigration Interviews with Indonesian Citizens Using Multi-Feature Facial Analysis

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Abstrak

Penelitian ini mengembangkan sistem pendeteksi kebohongan berbasis kecerdasan buatan Machine learning untuk membantu petugas Imigrasi dalam mengevaluasi wawancara permohonan paspor warga negara Indonesia dengan pendekatan yang lebih sistematis melalui penggunaan teknologi computer vision guna menganalisis fitur-fitur yang ditampilkan oleh wajah manusia. Set data penelitian menggunakan 32 video wawancara (23 honest, 9 lie) yang diaugmentasi menjadi 41 video untuk mengatasi ketidakseimbangan kelas. Sistem menggunakan dlib dan OpenCV untuk mendeteksi 68 facial landmarks, mengekstrak tiga parameter perilaku wajah, yakni : bagian mata, bagian alis, dan bagian bibir. Analisis statistik comprehensive menghasilkan 66 fitur diskriminatif per video. Model CNN, CNN-LSTM, dan ANN dikembangkan untuk diujicobakan dalam penelitian ini. Model dilatih dengan 5 K-fold cross-validation sebanyak tiga kali dengan hasil evaluasi menunjukkan ANN mencapai test accuracy terbaik yaitu 74.4%, precision 79.3%, recall 74.4%, dan F1-score 73.4%. Analisis feature importance mengidentifikasi Mouth Asymmetry Std sebagai parameter paling diskriminatif dengan nilai sebesar 0.4114. Sistem kemudian diimplementasikan dalam web application dengan processing time sekitar lima menit per video, menyediakan confidence score dan final decision untuk analisis petugas. Kontribusi penelitian meliputi multi-feature facial analysis dan end-to-end system serta saran pengembangannya untuk aplikasi praktis wawancara paspor di kantor Imigrasi Indonesia yang diharapkan dapat menjadi solusi inovatif dalam mendukung pengambilan keputusan di instansi Imigrasi dan meningkatkan kualitas layanan publik terkait.
.....This research develops an artificial intelligence-based lie detection system using machine learning to assist Immigration officers in evaluating passport application interviews for Indonesian citizens through a more systematic approach utilizing computer vision technology to analyze features displayed by human faces. The research dataset uses 32 interview videos (23 honest, 9 lie) which were augmented to 41 videos to address class imbalance. The system employs dlib and OpenCV for detecting 68 facial landmarks, extracting three facial behavioral parameters: eye region, eyebrow region, and lip region. Comprehensive statistical analysis yields 66 discriminative features per video. CNN, CNN-LSTM, and ANN models were developed and tested in this research. Models were trained using 5 K-fold cross-validation performed three times, with evaluation results showing that ANN achieved the best test accuracy of 74.4%, precision of 79.3%, recall of 74.4%, and F1-score of 73.4%. Feature importance analysis identified Mouth Asymmetry Standard Deviation as the most discriminative parameter with a value of 0.4114. The system was then implemented as a web application with a processing time of approximately five minutes per video, providing confidence scores and final decisions for officer analysis. Research contributions include multi-feature facial analysis and end-to-end system development, along with recommendations for practical implementation in passport interview applications at Indonesian Immigration offices, which is expected to serve as an innovative

solution in supporting decision-making at Immigration agencies and improving related public service quality.