

MODEL DEVELOPMENT FOR PUSH UP COUNTING BY UTILIZING BODY LANDMARKS AND LSTM ALGORITHM

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ABSTRAK

Perhitungan repetisi push-up secara manual rentan mengalami permasalahan penilaian yang subjektif membuat penilai menjadi tidak konsisten. Dalam penilaian gerakan push-up tidak hanya dengan terpenuhinya posisi atas dan bawahnya, namun secara keseluruhan termasuk transisi antar posisi push-up. Penelitian ini bertujuan mengembangkan model perhitungan dan validasi gerakan push-up. Memanfaatkan *body landmarks* dan algoritma *Long Short-term Memory* (LSTM) yang mampu mengenali pola gerakan secara temporal dan konsisten. Dengan melakukan klasifikasi pada 10 kelas gerakan dengan 1 kelas gerakan benar dan 9 kelas gerakan salah untuk menjaga keseimbangan data antar kelasnya. Sebanyak 3600 data video dilakukan ekstraksi *landmarks* dan pemilihan fitur-fitur yang digunakan. Fitur yang digunakan terdiri dari 4 data sudut sendi dan 7 data *keypoint* yang terdiri dari nilai x, y dan z. Dilakukan juga normalisasi data penambahan *padding* untuk menyeragamkan panjang data. Data dibagi menjadi 80% untuk pelatihan dan 20% untuk pengujian. Model dikembangkan menggunakan arsitektur LSTM dengan lapisan *masking* dan *dropout*, serta menggunakan skema *k-fold cross validation*. Dilakukan pengujian pada 8 arsitektur model yang berbeda dan percobaan perubahan nilai *learning rate* dan penambahan regularisasi. Evaluasi kinerja model dilakukan dengan menggunakan matriks konfusi, terdiri dari metrik akurasi, *recall*, presisi dan *F1-score*. Hasil training menunjukkan arsitektur model yang terbaik memperoleh akurasi pengujian 94,02% pada fold terbaiknya. Selain itu, dibangun juga sebuah simulasi sebagai implementasi model yang diuji dengan 15 video dengan total 166 repetisi didalamnya. Dengan pengujian dilakukan pada 5 perangkat yang berbeda. Hasil pengujian simulasi diperoleh akurasi 99,40% dalam deteksi repetisi push-up. Dalam melakukan klasifikasi gerakan push-up diperoleh akurasi 95.09% dengan latensi berkisar 43 ms sampai 47 ms. Hasil penelitian ini diharapkan dapat memberikan kontribusi dalam pengembangan perhitungan push-up otomatis yang disertai dengan penilaian gerakan.

Kata kunci: Push-Up, Body Landmarks, Long Short-Term Memory, Klasifikasi, Validasi Gerakan, Repetisi Push-Up

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ABSTRACT

Manual push-up repetition counting is prone to subjective assessment problems, resulting in inconsistent assessments. In assessing push-up movements, it is not only the upper and lower positions that must be fulfilled, but also the overall transition between push-up positions. This study aims to develop a model for calculating and validating push-up movements. It utilizes body landmarks and the Long Short-term Memory (LSTM) algorithm, which is capable of recognizing movement patterns temporally and consistently. Classification is performed on 10 movement classes, with 1 correct movement class and 9 incorrect movement classes to maintain data balance between classes. A total of 3600 video data were used for landmark extraction and feature selection. The features used consisted of 4 joint angle data and 7 keypoint data consisting of x, y, and z values. Data normalization and padding were also performed to standardize the data length. The data were divided into 80% for training and 20% for testing. The model was developed using an LSTM architecture with masking and dropout layers, as well as a k-fold cross validation scheme. Testing was carried out on 8 different model architectures and experiments were conducted on changing the learning rate and adding regularization. Model performance was evaluated using a confusion matrix, consisting of accuracy, recall, precision, and F1-score metrics. The training results showed that the best model architecture achieved a testing accuracy of 94.02% on its best fold. In addition, a simulation was also built as an implementation of the model tested with 15 videos with a total of 166 repetitions in it. The testing was carried out on 5 different devices. The simulation test results obtained an accuracy of 99.40% in detecting push-up repetitions. In classifying push-up movements, an accuracy of 95.09% was obtained with a latency ranging from 43 ms to 47 ms. The results of this study are expected to contribute to the development of automatic push-up counting accompanied by movement assessment.

Keywords: Push-Up, Body Landmarks, Long Short-Term Memory, Classification, Movement Validation, Push-Up Repetitions.