ABSTRACT

The use and development of technology has become increasingly rapid since the COVID-19 pandemic occurred at the end of 2019 to 2022. Considering that the COVID-19 virus can spread through hand touch, the use of technology in public spaces requires users to minimize hand touching. Various research was carried out and produced a technology called touchless technology. Touchless technology provides a solution for accessing technology that we commonly use in public spaces. There are many ways to use touchless technology, and one of them is through eye movements. Eye movement-based systems have been developed for more than 30 years, but are still underused in the realm of touchless technology. In processing input in the form of eye movements, an artificial intelligence model is needed to classify eye movements properly. The method used in eye movement classification involves traditional machine learning, although eye movements have many important features that can be learned. Therefore, deep learning is recommended for use. Deep learning models are also optimized using hyperparameter tuning because the results of deep learning models are generally not optimal. In other words, deep learning models can be further optimized by setting the model's hyperparameters.

This research proposes the use of deep learning models in eye movement classification, and improves the accuracy of the resulting models using hyperparameter tuning methods. The deep learning models tested in this research are Long Short-Term Memory, Bidirectional Long Short-Term Memory, Temporal Convolutional Network, and Gated Recurrent Unit. The model selection is based on the model's ability to process time-series data such as eye movement data. Meanwhile, the hyperparameter tuning methods that will be used are searching methods in the form of Grid Search, Randomized Search, and Bayesian Optimization. The hyperparameters that will be optimized are initialization mode (weight), activation, learning rate, and optimizer.

The best model will be compared with other deep learning models as a performance benchmark, then the results of the hyperparameter tuning process will be compared with each other. This research produced the best accuracy with a value of 0.7901 and an F-1 Score with a value of 0.7865. These results were obtained from the Bidirectional Long Short-Term Memory model using the hyperparameter tuning method in the form of Bayesian Optimization. The implication of this research is a form of developing touchless technology based on eye-tracking.

Keywords – Optimization, accuracy, hyperparameter tuning, deep learning, eye movement classification, eye tracking

INTISARI

Penggunaan dan perkembangan teknologi menjadi semakin pesat sejak terjadinya pandemi COVID-19 di akhir tahun 2019 hingga 2022. Mengingat virus COVID-19 bisa menyebar melalui sentuhan tangan, penggunaan teknologi di ruang publik mengharuskan penggunanya untuk meminimalisir sentuhan tangan. Berbagai penelitian dilakukan dan menghasilkan sebuah teknologi yang disebut dengan *touchless technology*. *Touchless technology* memberikan solusi dalam akses teknologi yang umum kita gunakan di ruang publik. Terdapat banyak cara dalam menggunakan *touchless technology*, dan salah satunya adalah melalui gerakan mata. Sistem berbasis gerakan mata sudah dikembangkan selama lebih dari 30 tahun lamanya, namun masih kurang digunakan di ranah *touchless technology*. Dalam memproses masukan berupa gerakan mata ini, dibutuhkan sebuah model kecerdasan buatan untuk mengklasifikasikan gerakan mata dengan baik. Metode yang digunakan dalam klasifikasi gerakan mata melibatkan *machine learning* secara tradisional, terlepas gerakan mata memiliki banyak fitur penting yang dapat dipelajari. Maka dari itu, *deep learning* disarankan untuk digunakan. Model *deep learning* juga dioptimasi menggunakan *hyperparameter tuning* karena hasil dari model *deep learning* umumnya belum optimal. Dengan kata lain, model *deep learning* dapat dioptimasi lebih lanjut melalui pengaturan *hyperparameter* yang dimiliki model tersebut.

Penelitian ini mengusulkan penggunaan model *deep learning* dalam klasifikasi gerakan mata, dan meningkatkan akurasi model yang dihasilkan dengan menggunakan metode *hyperparameter tuning*. Model *deep learning* yang diuji dalam penelitian ini adalah *Long Short-Term Memory*, *Bidirectional Long Short-Term Memory*, *Temporal Convolutional Network*, dan *Gated Recurrent Unit*. Pemilihan model tersebut didasarkan pada kemampuan model dalam memproses data yang bersifat *time-series* seperti data pergerakan mata. Sedangkan metode *hyperparameter tuning* yang akan digunakan adalah metode *searching* berupa *Grid Search*, *Randomized Search*, dan *Bayesian Optimization*. *Hyperparameter* yang akan dioptimasi adalah *initialization mode* (*weight*), *activation*, *learning rate*, dan *optimizer*.

Model terbaik akan dibandingkan dengan model *deep learning* lain sebagai tolak ukur performa, kemudian hasil dari proses *hyperparameter tuning* akan dibandingkan satu sama lain. Penelitian ini menghasilkan akurasi terbaik dengan nilai 0,7901 dan F-1 Score dengan nilai 0,7865. Hasil tersebut didapat dari model *Bidirectional Long Short-Term Memory* dengan metode *hyperparameter tuning* berupa *Bayesian Optimization*. Implikasi penelitian ini merupakan sebuah bentuk pengembangan *touchless technology* berbasis *eye-tracking*.

Kata kunci – Optimasi, akurasi, *hyperparameter tuning*, *deep learning*, klasifikasi gerakan mata, *eye tracking*