ABSTRACT

Visually impaired individuals in Indonesia, numbering over 3.75 million, face various challenges in their daily lives, including difficulties in independently identifying Rupiah banknotes. This situation makes visually impaired individuals vulnerable to counterfeit money scams, primarily due to limited accessibility and available technology to support their needs. The current solution, the blind code feature on banknotes, remains ineffective in helping visually impaired people identify counterfeit money. Existing systems are inadequate to address this issue comprehensively. This study developed a system to identify the authenticity of Rupiah banknotes from the 2016 and 2022 emissions using a fine-tuning method on the Convolutional Neural Network (CNN) architecture and pre-trained models, specifically EfficientNetV2B2 and VGG-19 architectures. The study also applied image augmentation techniques and hyperparameter tuning with Optuna to enhance the accuracy and effectiveness of the model in performing identification tasks. The results showed that the EfficientNetV2B2 architecture outperformed with an Accuracy of 94%, F1-Macro of 93%, Precision-Macro of 92%, Recall-Macro of 93%, and ROC-AUC Score of 98%. Additionally, this architecture was more efficient in terms of training time, with an average of 43.88 epochs and a total training time of 1847.50 seconds. However, image augmentation and hyperparameter tuning did not significantly improve model performance, with a decrease in Recall-Macro to 77% and 81% for each method, respectively. This study also includes the real-time deployment of the model using TensorFlow Lite on the Flutter framework. Real-time testing showed that the model implemented in the Flutter application successfully identified all samples of genuine banknotes with a confidence level above 90%. However, the model failed to predict counterfeit money accurately, as indicated by lower confidence levels compared to genuine money, with the highest confidence for counterfeit money being 49.76% for a counterfeit Rp20,000 banknote from the 2016 emission. Therefore, an increase in the model's sensitivity to counterfeit money is necessary to provide higher confidence in real-time predictions. The study also recommends further exploration of more appropriate augmentation transformations and extended hyperparameter tuning durations to achieve the desired performance

improvements. These findings are expected to provide broad benefits, not only enhancing the independence and security of financial transactions for visually impaired individuals but also raising public awareness of inclusivity issues, providing guidance for educational institutions in technology development, and serving as a concrete example for technology developers in creating socially impactful and inclusive solutions.

Keywords—Visually Impaired, Counterfeit Currency, Fine-Tuning, Convolutional Neural Networks, Pre-Trained Model, Image Augmentation, Hyperparameter Tuning, Optuna, Flutter