

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the main findings derived from the analyses and experimental results discussed throughout the preceding chapters. The conclusions are formulated in relation to the research objectives concerning the implementation of the Contrast Limited Adaptive Histogram Equalization (CLAHE) technique and the transfer learning approach using ResNet-18 for handwritten Katakana character recognition. Furthermore, several suggestions are proposed to provide directions for future studies.

5.1 Conclusions

The findings obtained in this study lead to the following conclusions:

1. The transfer learning-based ResNet-18 architecture demonstrated strong capability in recognizing handwritten Katakana characters. The optimal parameter configuration was achieved using 70:15:15 dataset partition, learning rate 0.001, batch size 16, Adam optimizer, 50 training epochs, and CLAHE settings consisting of a clip limit value of 2.0 together with a tile grid size of 8×8 .
2. Incorporating CLAHE as a preprocessing procedure contributed positively to the classification capability of the ResNet-18 model. Experimental evaluation of CLAHE parameters showed that the combination of a clip limit of 2.0 and a tile grid size of 8×8 generated superior results compared with the alternative parameter settings evaluated in this study.
3. Averaged over ten independent experimental runs, the ResNet-18 model combined with CLAHE obtained an accuracy of 95.10%, precision of 95.43%, recall of 95.10%, and F1-score of 95.09%. Meanwhile, the model trained without CLAHE achieved an accuracy of 89.75%, precision of 91.19%, recall of 89.85%, and F1-score of 89.94%. These findings suggest that contrast enhancement through CLAHE improves the visual

characteristics of the input images and facilitates more effective feature extraction by the classification model.

4. The average performance observed across ten repetitions consistently showed that the CLAHE-enhanced model surpassed the model without preprocessing for all evaluation metrics. This observation indicates that CLAHE represents a suitable image enhancement strategy for improving handwritten Katakana recognition performance using the ResNet-18 architecture.

5.2 Recommendations

Considering the outcomes obtained in this research, several recommendations can be proposed for future work:

1. Future studies may extend the scope of classification beyond single-syllable Katakana characters to include Katakana characters with diacritical marks, combined characters, as well as Hiragana and Kanji characters. Such an extension would enable further examination of model performance under larger and more complex classification scenarios.
2. Future research may utilize larger datasets with more diverse handwriting styles and investigate other preprocessing techniques besides CLAHE to achieve higher classification performance.
3. Future studies may develop a real-time handwritten character recognition system based on cameras or scanners, allowing character identification to be performed directly from captured handwriting. Such developments could support applications in Japanese language learning and automatic handwritten document digitization.