

CHAPTER V CONCLUSION

This chapter serves as the concluding section of the study, presenting conclusions based on the entire research process, as well as recommendations for future development. Following the stages of data processing, model design and training, and evaluation—both quantitative and through user testing—this section summarizes the key findings. Additionally, it offers reflections on the research findings as a basis for refinement and further development.

5.1. Conclusion

Based on the entire series of research and experiments conducted, the following conclusions were drawn:

1. A color correction pipeline was successfully designed by integrating the U-Net model, the Pix2Pix model, and a combination of U-Net and Pix2Pix into a single processing workflow. Based on the experimental results, the best model was obtained using U-Net with a learning rate of 0.0003, which produced the highest SSIM value of 0.8405 and the lowest Delta E of 10.65, thereby providing an optimal balance between image structural quality and color accuracy.
2. The U-Net model has proven capable of improving image reconstruction quality, particularly in preserving structure and pixel detail through its skip connection mechanism. This is demonstrated by U-Net's SSIM values, which range from 0.8007 to 0.8405—higher than those of Pix2Pix, which only reach 0.7095–0.7112. Additionally, the Delta E values for U-Net, ranging from 10.65 to 11.66, are also lower than those of other methods, indicating better color accuracy.
3. The combination of U-Net and Pix2Pix has not yet been able to provide a significant performance improvement compared to using U-Net alone. This is evident from the SSIM values, which range from 0.7987 to 0.8065, and the Delta E values, which remain high at 21.26–21.98. Thus, increasing model complexity does not always directly correlate with improved color correction quality.

4. The developed system has been successfully implemented as a web-based application using Flask, allowing users to upload images, select a type of color blindness, and interactively view comparisons between RGB images and the corrected results. Based on user testing results, it was found that object recognition accuracy in RGB images remains higher than in the corrected results. For protanopia, accuracy decreased from 83.81% to 37.14%; for deuteranopia, from 81.27% to 71.75%; and for tritanopia, from 82.86% to 62.54%. This indicates that the system functions well, but its effectiveness in improving visual perception still needs to be enhanced.

5.2. Recommendations for Improvement

Based on the results of the research conducted, several recommendations can be proposed for consideration in future research, as follows::

1. Further research is recommended to develop models that are more adaptable to each type of CVD and to optimize the model architecture and parameters. This is important because the results of this study indicate that the system's performance is not yet consistent across all types of color blindness and, in some cases, still reduces object recognition accuracy. With these improvements, it is hoped that the correction results will not only be optimal in terms of metrics but will also tangibly enhance users' visual perception..
2. To obtain more representative results, future research is recommended to use a more diverse dataset and involve a larger number of respondents with a wider range of color blindness conditions. Additionally, the web-based system that has been developed could be enhanced into a mobile app to make it more practical and usable in real time in everyday life, so that users can directly experience its benefits.