CHAPTER V
CLOSING

5.1. Conclusion

Based on all research stages, which include data collection, model development, application implementation, as well as system testing and evaluation, several conclusions were obtained that indicate the research achievements as follows.

1. Detection of milkfish freshness level based on eye images was successfully performed using the YOLOv11 Nano model, which was able to classify fish into the categories of fresh, less fresh, and Busuk (Spoiled) with good performance, as indicated by Precision of 98.25%, Recall of 97.39%, mAP@50 of 98.69%, mAP@50-95 of 65.55%, and F1-Score of 97.82%.
2. Variations in training parameters affected the performance of the YOLOv11 Nano model. The best scenario was obtained by the second scenario with an 80%:10%:10% dataset split, a learning rate of 0.01, and 100 epochs, which yielded a Precision of 98.25%, a Recall of 97.39%, an mAP@50 of 98.69%, an mAP@50-95 of 65.55%, and an F1-Score of 97.82%.
3. The performance of the YOLOv11 Nano-based application showed good results, with an average processing speed of 288.83 ms per image and 3.46 FPS using the GPU, as well as 785 ms per image and 1.27 FPS using the CPU. The use of the GPU improved inference performance by 2.72 times compared to the CPU. In addition, the application exhibited efficient resource usage, with an average CPU usage of 14.9% and memory usage of 187.51 MB, thus enabling it to perform the detection and classification process quickly with relatively low resource requirements.

5.2. Recommendations

Based on the findings of this study, the following suggestions are proposed for future research development:

1. Increasing the quantity and diversity of the dataset used in the model training process, so that the model can better recognize the characteristics of fish freshness levels under various environmental conditions, image capture angles, and lighting variations.
2. Conducting testing on fish species other than milkfish to evaluate the model's generalization capability on different objects.
3. Conducting testing under more diverse environmental conditions, such as variations in image capture distance, lighting intensity, and image acquisition angles.