

Chapter V

CONCLUSION

This chapter contains the conclusions obtained from the research results based on the research objectives that have been set. The conclusions are compiled based on the test results and discussion regarding the evaluation of YOLOv8 training configurations for detecting abnormalities in bovine spermatozoa heads. In addition, this chapter also presents several suggestions that are expected to serve as a reference for further research in developing methods and improving the performance of the detection system.

5.1 Conclusion

Based on the research that has been conducted, starting from the data collection stage, image preprocessing using Contrast Limited Adaptive Histogram Equalization (CLAHE), YOLOv8 model development, up to the evaluation of various training configurations, the following conclusions can be drawn.

1. This research successfully applied a deep learning method using the YOLOv8 architecture to detect abnormalities in the shape of bovine spermatozoa heads. Before the training process, images were processed using Contrast Limited Adaptive Histogram Equalization (CLAHE) to improve image quality. The trained model was then successfully implemented into a Streamlit-based application, enabling automatic detection of the two classes, namely normal and abnormal.
2. Based on the test results for 27 scenarios, which are combinations of optimizer, learning rate, and number of epochs, the best configuration was obtained in scenario c.4, which uses the RMSProp optimizer, a learning rate of 0.01, and 75 epochs. This configuration produced an accuracy of 95.56%, an mAP@0.5 of 91.76%, a precision of 89.81%, a recall of 88.38%, and an F1-score of 89.08%. These results indicate that the YOLOv8 architecture is able to detect abnormalities in the shape of bovine spermatozoa heads with a good level of accuracy on the dataset used in this study.

5.2 Development Suggestions

Based on the research findings and the limitations still present in this study, several recommendations can be offered for consideration in the development of future research and the implementation of a YOLOv8-based sperm head abnormality detection system. The recommendations are as follows.

1. Increase the size and variety of the dataset—in terms of lighting conditions, microscope quality, and sperm morphology—to improve the model's generalization ability.
2. Conduct a more extensive exploration of hyperparameters, such as variations in learning rate, batch size, momentum, weight decay, and other optimizers, to obtain a more optimal training configuration.
3. Expand the research by comparing several variants of the latest YOLO models or other object detection models to identify the model that delivers the best performance in detecting bovine sperm abnormalities.
4. Add quantitative analysis features to the application, such as automatic calculation of the percentage of abnormalities, storage of detection results, and report generation, so that the application is better prepared for use in the semen evaluation process in the laboratory.