DEEP LEARNING-BASED UNDERBODY VEHICLE WIRELESS AUTOMATED INSPECTION SYSTEM

BFM4914 - FINAL YEAR PROJECT 2

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ABSTRACT

The automotive industry's key role in Malaysia highlights the urgent need for accurate vehicle inspection systems due to increasing vehicle numbers and road accidents. This research introduces a novel underbody vehicle inspection system for vehicle model Tiguan Allspace Highline using deep learning, specifically the YOLO algorithm, to improve manual inspection efficiency, reduce human error, enhance safety and optimize data management. The study implements YOLO with a collected dataset, develops a user interface with Streamlit, enables wireless image capture for object detection, and integrates a MySQL database for data management. Results show YOLOv9c achieving the highest precision (0.983) and recall (0.961), closely followed by YOLOv7 (precision 0.977, recall 0.950), while YOLOv8l had lower results (precision 0.959, recall 0.958). This research contributes to the automotive industry by offering a highly efficient, time-saving and automated wireless method for underbody vehicle inspections.

PROBLEM STATEMENT

- Manual underbody vehicle inspection are highly time-consuming
- Higher occurrence of human error for manual inspection
- Inefficient and various hazards might occur when doing manual vehicle inspection
- Difficulties and inefficient in manual handwritten data recording

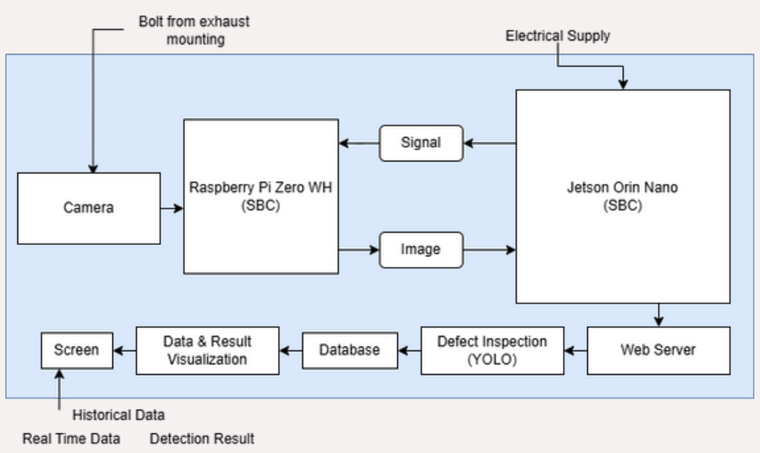
AIM & OBJECTIVES

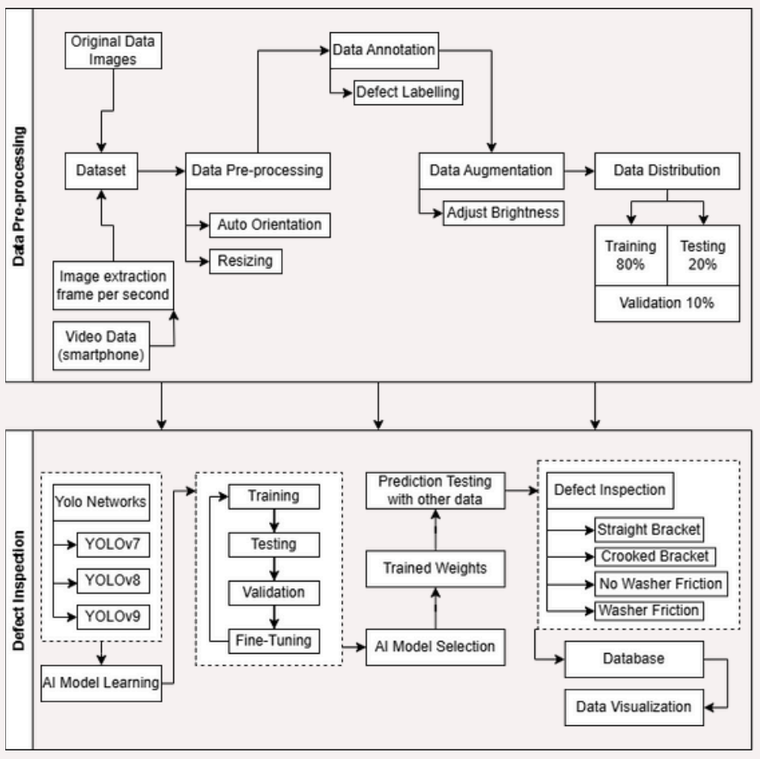
- To collect dataset, pre-process and train a model for automatic underbody vehicle inspection
- To develop a constructive system website with step-by-step instruction for underbody vehicle inspection
- To enhance the system by upgrading object detection to wireless defect inspection
- To design a digital database for data management and display

SCOPE

- Identify defect types and train YOLO algorithms with pre-processed data
- Develop a real-time wireless defect inspection GUI using Streamlit
- Integrate MySQL database for efficient data management
- Deploy the system, integrating UI and data manage for real-world use

METHODOLOGY





RESULTS

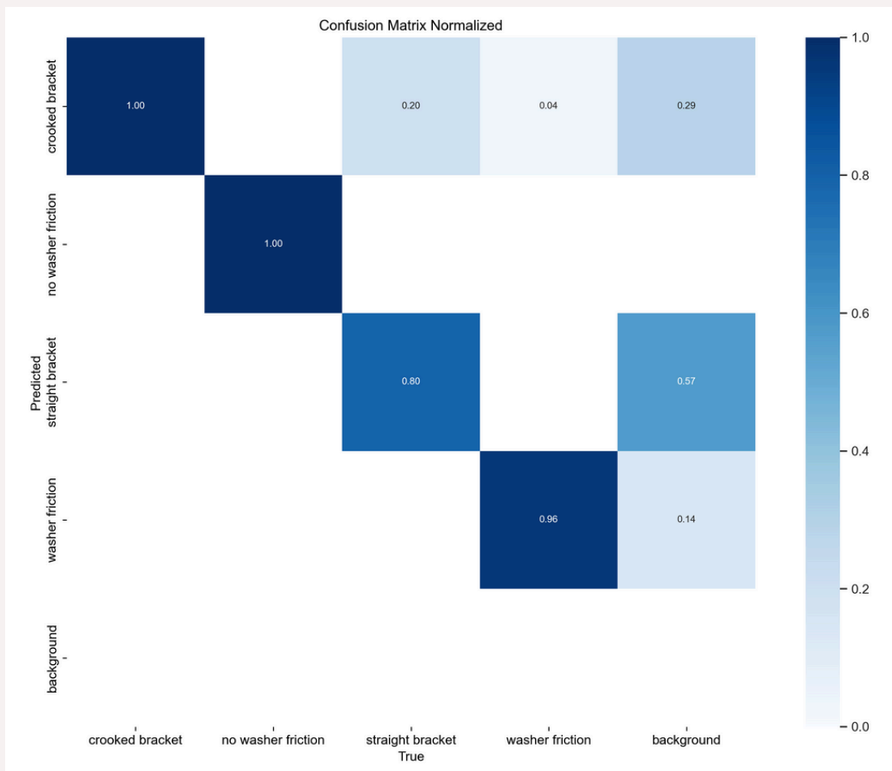
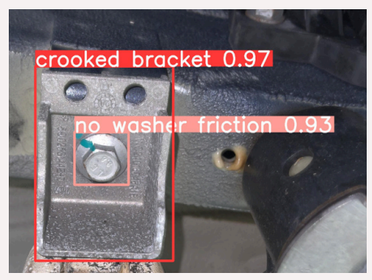
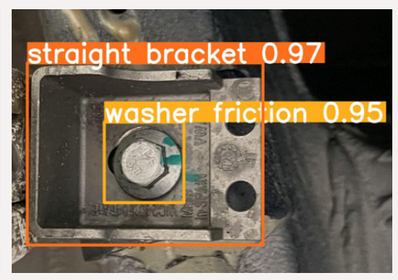
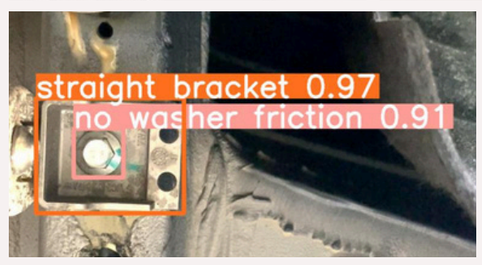


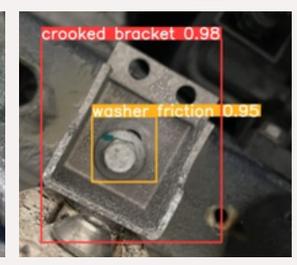
Table 1. Results Comparison of YOLOv7, v8 and v9

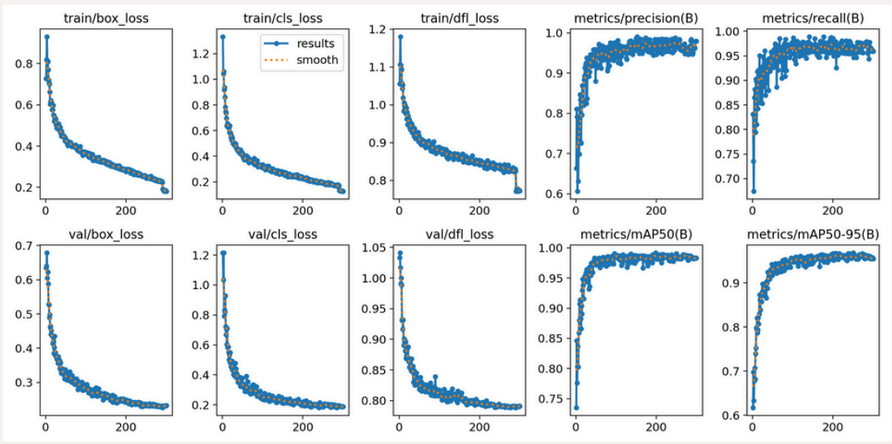
Model	Precision Value	Recall Value	mAP50-95
YOLOv7	0.977	0.950	0.947
YOLOv8l	0.959	0.958	0.964
YOLOv9c	0.983	0.961	0.968

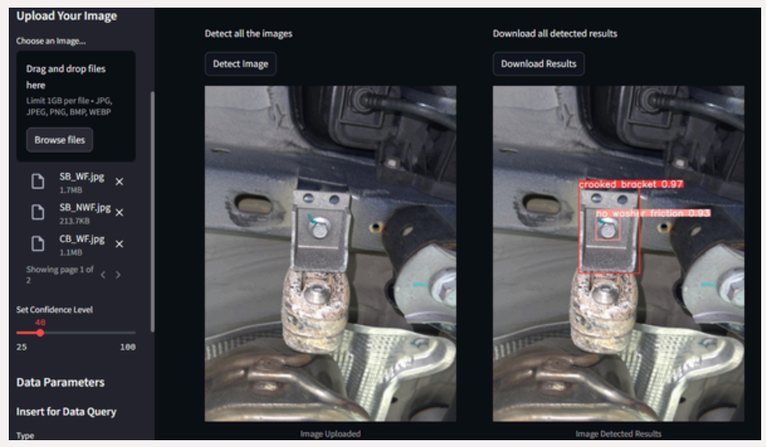


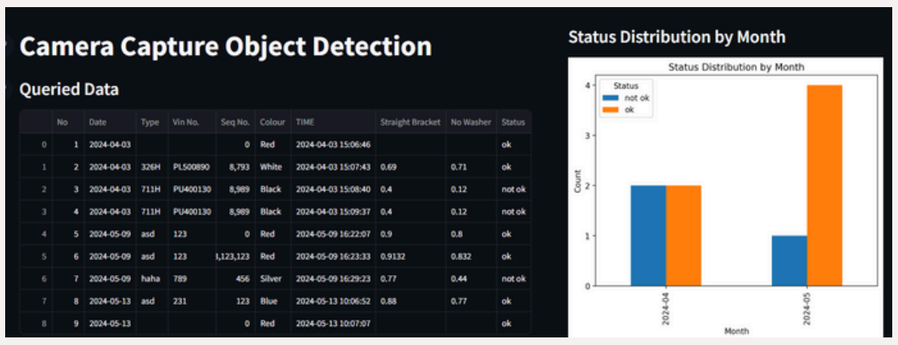


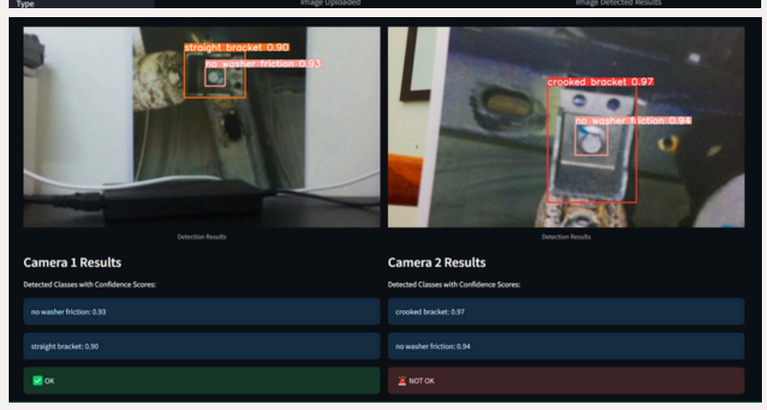












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[1] L. Yang, Y. An, N. Wu, P. Chen, H. Cheng,and X. Zhao, "A petrinet-based heuristic algorithm for short-term vehicle scheduling in a vehicle inspection system," IEEE Access, vol. 7, pp. 138442–138460, 2019, doi: 10.1109/ACCESS.2019.2942851.

[2] E. E. Ruiz and K. L. Head, "Use of an automatic under-vehicle inspection system as a tool to streamline vehicle screening at ports of entry and security checkpoints," in Proceedings - 2012 European Intelligence and Security Informatics Conference, EISIC 2012, 2012, pp. 329–333. doi: 10.1109/EISIC.2012.64.

SETUP

NVIDIA JETSON, PyCharm, MySQL phpMyAdmin, Introducing #PIZERO, ultralytics, Streamlit

CONCLUSIONS

- YOLOv9c achieved the best performance results with precision 98.3% and recall 96.1%
- The bolt on exhaust mounting can be detected wirelessly with the use of GUI and codes designed
- Data and results can be stored and displayed in the web.
- Other different kinds of feature defect inspection have been developed for user-friendly purposes

FUTURE WORK

- Upgrade of Pi Zero WH with a higher processing power, RAM and CPU core board for the camera for a faster respond time.
- Increasing of dataset and training epochs with modification of annotation for a better defect detection.
- Replacing of camera with a higher resolution, pixels and fps to have a better data image capturing.
- Integration of other defect inspection system into Jetson to undergo full inspection of underbody vechicle.