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Comparison of Different Optical Flow Methods

on Optical Flow Based Out-of-Distribution Detection

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Project Objectives:

In Cyber Physical Systems (CPS), object detection is a crucial aspect that ensures the safe and robust autonomous operation of such systems. However, studies have suggested that these object detection algorithms are susceptible to anomalies that are falsely classified. Consequently, there is a need to develop high-performing Out-of- Distribution (OOD) detection algorithms for such systems.

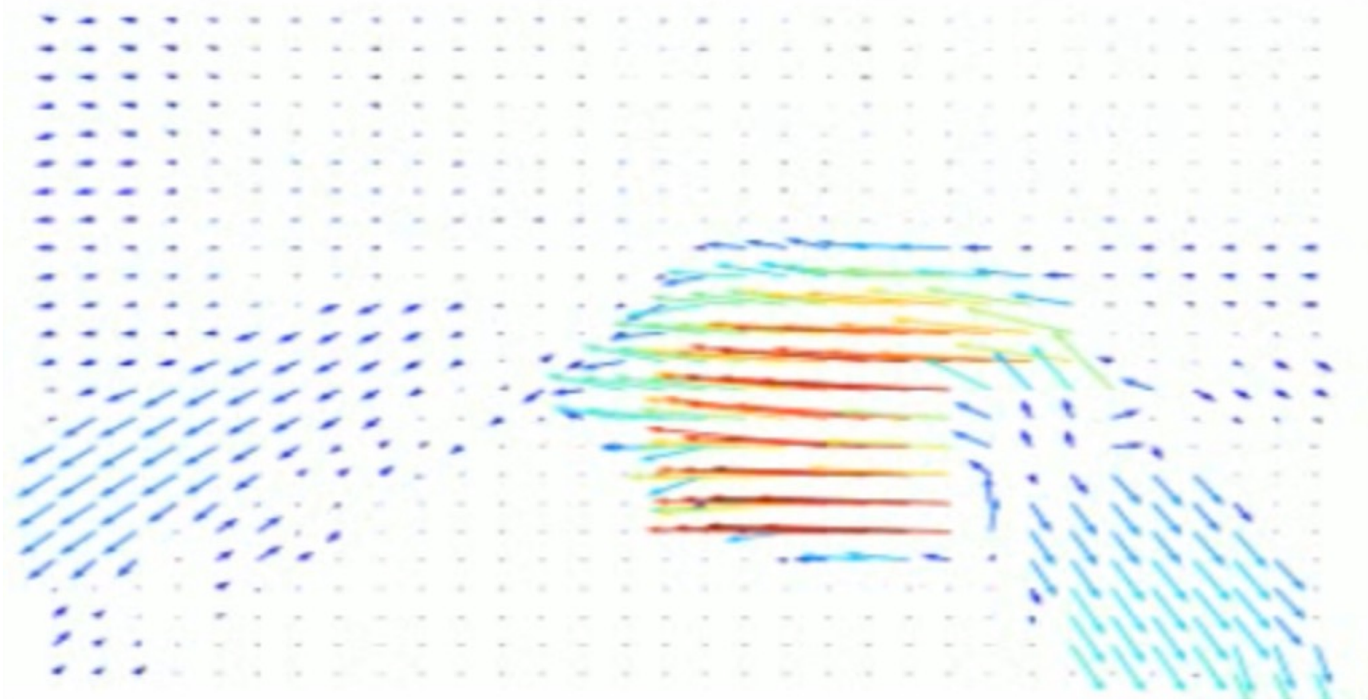
The use of optical flow as a motion detection algorithm has historically been well- documented, and works have been done to incorporate optical flow into Variational Autoencoders (VAEs). This project proposes another method of OOD detection by incorporating the Lucas-Kanade model into a VAE. This proposed model is compared against an existing optical flow-based VAE that was implemented with the Farneback algorithm, and the performance and accuracy of both models were tested with a dataset that was self-collected.

Method:

Collection of the data was done with two duckiebots running ROS2, collecting a total of 43 different scenes which contain over 20,000 frames for model training.

Evaluation of the models were based on two key metrics – Performance and Accuracy. Performance included training time and execution time, while accuracy included the Area Under the Receiving Operating Characteristic (AUROC) score. The closer the AUROC score is to 1, the better the model performs.

	Training Time	Execution Time	AUROC Score
Farneback Optical Flow	3 hours 5 minutes 12 seconds	1 minute 52.2 seconds	0.36649925481309076
Lucas-Kanade Optical Flow	30 minutes 12 seconds	13 seconds	0.7389804209795635



Conclusion:

The proposed model outperforms the existing model by quite a large margin. Performance has significantly improved by being up to 6 times faster in training and 8 times faster in execution. Accuracy was also largely better as compared to the existing Farneback model against the test data.

This could be useful in CPS such as autonomous vehicles where computational power is a scarce resource that should be managed efficiently. Moreover, this could present a new perspective towards high-performing OOD detection algorithms by offering a novel innovation in this space.