CPS843 - Progress Report

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Regression based algorithms are one of the pillars of object recognition and image processing technology in the rapidly advancing field of self-driving vehicles. This progress report outlines our approach in employing Convolution Neural Networks (CNNs) as the chosen regression model. Acknowledging the model's vulnerability to uncertainty, Bayesian neural networks are to be integrated for improved robustness. Varying conditions in testing may help optimize reliability, and can apply in autonomous driving scenarios.

We plan to work with a regression-based algorithm, as their ability to compare variables from visual input and use repeated imagery results in quicker image sampling. This would generally improve the reliability of image processing and object recognition in the neural network of self-driving vehicles. The regression model we choose to work with in this process is the Convolution Neural Networks. It is the ability to map out of the inputs that is given via sensory input to explore the spatial relations that are within a processed image [1]. This system is used in processing and object recognition due to its ability to assign the importance of each piece of the object to be used in a self learning process. This is then translated to aspects of the object that the network can detect so it can differentiate towards other references it may use. Due to this it can be of great aid when having the ability to differentiate different vehicles, and most importantly the spatial awareness the vehicle would need in order to process the images inputting the system. The other aspect of CNN is that it is able to learn the filters and training in an easier manner compared to other algorithms tasked with the same filters.

This is notably useful in the mechanics of a self-driving vehicle's image processing as in end to end learning frameworks, as [2] outlines that CNN transforms sensory input into essential perception indicators. In this project's use case, the input would be from any cameras or sensory hardware provided by the vehicle. The direct perception paradigm of the model would allow for simultaneous learning and application of regression tasks for accurate estimation for any driving or road related information, as further outlined in [2]. However, CNN and the use of the model in self-driving vehicles today is extremely vulnerable to handling uncertainty, as it may struggle to provide accurate predictions when faced with uncertain or ambiguous situations on the road. By incorporating uncertainty-aware models such as Bayesian neural networks to estimate prediction uncertainty and improve uncertain scenario decision making, the robustness of CNN can be improved for future use in newer image recognition systems in self-driving vehicles.

We plan to execute this through running simulations with these algorithms under different conditions, including but not limited to different image clarities, data sets of varying sizes, and including large outliers in the data to account for improving uncertainty estimation. Using the results from these trials we are then given an output with differing levels of confidence and accuracy. To perform these simulations we plan to run them through terminal scripts or through the use of Python utilizing relevant libraries, the results of which will be outlined in the final report.

References

[1] Saha, S "A Comprehensive Guide to Convolutional Neural Networks" *Towards Data Science* (2018).
https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

[2] Lee, DH., Chen, KL., Liou, KH. et al. "Deep learning and control algorithms of direct perception for autonomous driving." *Appl Intell* 51, 237–247 (2021).
https://doi-org.ezproxy.lib.torontomu.ca/10.1007/s10489-020-01827-9