Vehicle damage detection with deep learning

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Introduction

- Goal of the research:
  - To build deep learning algorithm to identify damaged areas.

- Problem question:
  - How to build car damage detection algorithm that robust to under various conditions such as lighting conditions, inconsistency in human input etc?

Related work

In this work, we can summarise it into two categories, Single model and Multiple models architecture

Architecture types	Models	Classification types	Data collection & pre-process	Transfer learning?	Resource
Multiple models	Stage 1 –VGG16 Stage 2 – VGG16 Stage 3 – VGG16	Image classification with no localization	- 1840 training images - 460 validation images - Manual labeling	Yes, ImageNet pre-trained weight except fully connected layer	https://github.com/neokt/car-damage-detective
	Stage 1 –DenseNet Stage 2 – DenseNet Stage 3 – DenseNet Object detection – Yolo3	Image classification with object detection	- Dataset same as https://github.com/neokt/car-damage-detective - Data augmentation with rotation, horizontal flip, shear and zoom to enlarge the dataset.	Yes, ImageNet pre-trained for DenseNet except fully connected layer. yolov3_custom_4000.weights for yolo3	https://medium.com/analytics-vidhya/car-damage-classification-using-deep-learning-d29fa1e9a520
	Damage detection - VGG16 Object localization – Yolo	Image classification with object detection	- 1790 images curated from internet - ~ 460 images manually collected. - Manual annotation and bounding box.	Yes, both VGG16 and YOLO	Li et al. 2018

Related work cont..

Architecture types	Models	Classification types	Data collection & pre-process	Transfer learning?	Resource
Single model	Auto encoder CNN	Image classification and localization	- Curated from internet - 2471 training images - 621 test images - Manually annotated - Data augmentation with rotation to enlarge the data size	Yes	Patil et al. 2017
	Mask R-CNN	Object detection and segmentation	- Curated from internet - 50 train images - 16 validation images	Yes, COCO trained model	https://www.analyticsvidhya.com/blog/2018/07/building-mask-r-cnn-model-detecting-damage-cars-python/

Discussion

- Single model vs multiple models architecture.

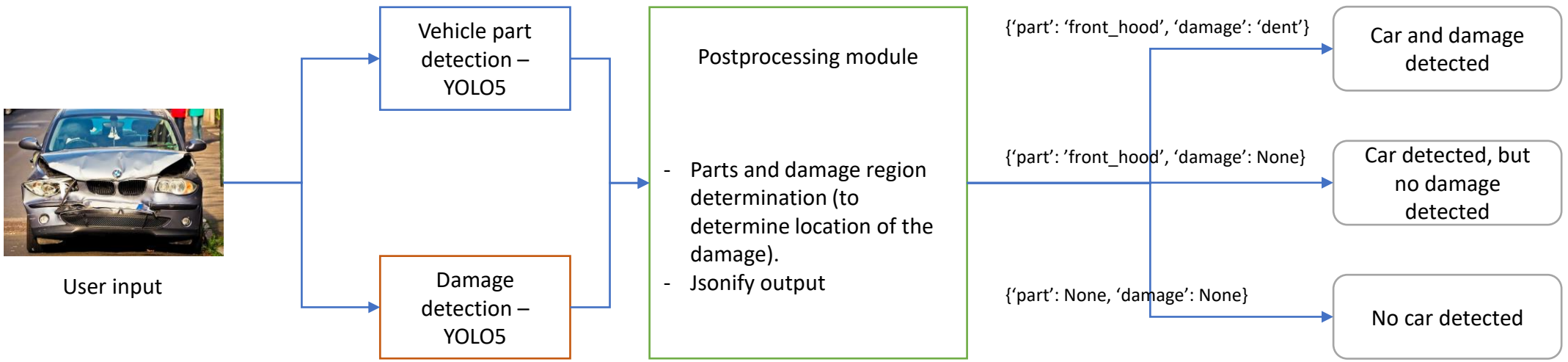
- Pre-processing techniques.
  - All researches curated their own data, most of it have low sample sizes and class imbalance.
  - Used data augmentation as pre-processing techniques to enlarge their datasets, and it increased the model classification accuracy (li et al. 2018, https://medium.com/analytics-vidhya/car-damage-classification-using-deep-learning-d29fa1e9a520).
  - van Ruitenbeek and Bhulai. (2022). Shows that data enlargement during pre-processing can improve the model to locate the objects. Combining public with controlled environment images also help in making model more robust.

- Transfer learning strategy.
  - All researches used transfer learning from pre-trained model to boost their model performances and reduce training time.

- Model architecture:
  - Single model:
    - Pros – faster, less computational burden, suitable for real-time application.
    - Cons –hard to finetune.
  - Multiple models:
    - Cons – high computational, slower inference process
    - Pros - suitable for multiple class classification and multiple experts scenario (e.g. damage classification & part detection for fraud detection by Li et al. 2018).

Discussion

- When it comes to production or real world application, there is always trade off between model performance and inference speed.
- Therefore, it is important to choose a deep learning architecture with real-time processing with acceptable accuracy such as YOLO, R-CNN etc.
- My propose architecture:



Reference

- Li, P., Shen, B., & Dong, W. (2018). An anti-fraud system for car insurance claim based on visual evidence. arXiv:1804.11207. URL: http://arxiv.org/abs/1804.11207.
- van Ruitenbeek, R.E and Bhulai, S. (2022). *Convolutional Neural Networks for vehicle damage detection. Machine Learning with Applications*, 9. (pp. 100332).
- Patil, K., Kulkarni, M., Sriraman, A., & Karande, S. (2017). Deep learning based car damage classification. In *ICMLA 2017*: *Vol. 2017-Decem*, *Proceedings - 16th IEEE international conference on machine learning and applications* (pp. 50–54). Institute of Electrical and Electronics Engineers Inc., http://dx.doi.org/10.1109/ICMLA.2017.0-179.