Vehicle Damage Volume Level Recognition Algorithm based on Convolution Neural Network and Yolo Model

Min Htet Thar
Research Team
EasyGeo Co.
Busan, South Korea
htatmin332@gmail.com

Man Zhang and Gi Ho Nam
Dept. of Computer Engineering
Tongmyong University
Busan, South Korea
mandyz0216@gmail.com,
lime18110060@gmail.com

Dong Myung Lee
Dept. of Computer Engineering
Tongmyong University
Busan, South Korea
dmlee@tu.ac.kr

***Abstract*— In this paper, we proposed a vehicle damage volume level recognition algorithm based on convolution neural networks (CNNs) and you only look once v5 (YOLO v5) model. The proposed algorithm consists of 4 models: a body part detection model, a damage inspection model, a damage classification model, and a damage volume level analysis model. This algorithm is proposed to automate the vehicle insurance claim process and it can help calculate the repair cost according to the level of vehicle damage volume. This study will be expected to be a very useful in the field of automating the auto insurance claim process and recognizing the level of vehicle damage.**

Keywords—Vehicle Damage, Object Detection, Image Classification, Data Analysis, CNN, YOLO

I. INTRODUCTION

Among previous studies, there are studies on vehicle damage recognition using a deep learning model, but it is not yet at the level that can be applied to the automobile insurance claim process. In most cases, it is not possible to determine the level of vehicle damage by recognizing only the type of damage because the types of vehicle damage are often similar.

Therefore, in this paper to improve this problem we propose an algorithm that can recognize the level of vehicle damage volume using 4 models: a body part detection model, a damage inspection model, a damage classification model, and a damage volume level analysis model. Ultimately, the purpose of the proposed algorithm is to fairly calculate the vehicle repair cost in case of a vehicle accident and to determine a fair negligence rate for vehicle accidents.

II. RELATED STUDIES

Many researchers have proposed several damage detection approaches and vehicle damage volume detection algorithms to reduce accident identification time and repair costs [1-4]. In recent years, convolutional neural networks (CNNs) have been used for many types of object detection, and in their applications, they have achieved much better performance than previous methods [3-4]. used the you only look once v5 (YOLO v5) model to determine the damaged part of the vehicle and the type of accident. YOLO v5 has the advantage of small amount of computation and fast recognition speed.

III. PROPOSED ALGORITHM

A. Problem Analysis

Most of the vehicle damage recognition technique based on deep learning are not at the damage volume level to be applied to the auto insurance claim process. In addition, since most types of vehicle damage are similar, it is necessary to determine the damage type as well as the degree of damage in order to apply it to a real situation. In previous studies [5-6],

we proposed an algorithm for recognizing the degree of damage by calculating the damaged body parts to solve this problem. However, the algorithms were presented to determine the degree of damage to a vehicle by counting only the number of damaged body parts, regardless of the degree of damage. Finally, these algorithms are not quite applicable to the auto insurance claim process. Therefore, we propose an algorithm that can improve these problems in this paper.

B. Design Philosophies

The basic design philosophy of the proposed algorithm mainly consists of two parts: a deep learning model and a damage level analysis model. The proposed algorithm is designed with CNN, YOLO model, car datasets, car damage datasets, and damage volume level analysis. Datasets are constructed from Kaggle, Coco datasets and other websites. The datasets are preprocessed using data augmentation methods, and each image in the dataset is labeled using an image annotation tool. These are trained using a pre-trained YOLO object detection model, a CNN image classification model with CNN.

A damage volume level analysis method will be established as data frame based on vehicle body parts, damage inspection, and damage class. In the process of vehicle damage recognition algorithm, each body part is first detected, and then damage inspection and damage classification are carried out. All of these results are then used to analyze the level of damage using data frames.

C. Proposed Algorithm

The proposed algorithm consists of vehicle body parts detection model, vehicle damage inspection model, vehicle damage classification model, and vehicle damage volume level analysis as shown in Fig. 1. A body part is detected using the body part detection model, and whether each body part is damaged is checked using the vehicle damage inspection model. The damaged part is given a damage grade according to the damage class. The results of these 3 models are used as parameters for analyzing the data frame of the damage level analysis model.

1) Vehicle Body Parts Detection Model: The function of the vehicle part detection model is to detect body parts such as front bumper, rear bumper, front door, tailgate, hood, lamp. The architecture of the vehicle body part detection model consists of the automotive dataset and the YOLO data model. During the detection process, the model detects all vehicle

parts in the image. The results of the detected vehicle body parts are then collected as parameters for the data frame of the vehicle damage volume level analysis model.

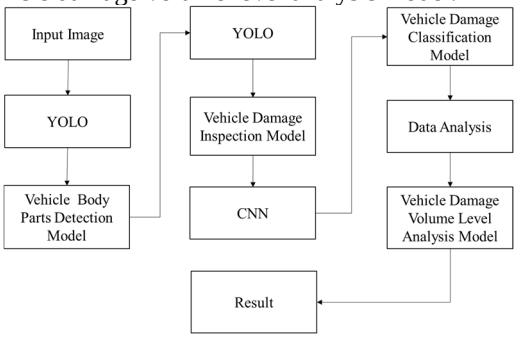

Fig. 1. Overview of proposed algorithm.

2) Vehicle Damage Inspection Model: The function of the vehicle damage inspection model uses images to detect any damage to the vehicle as shown in Fig. 2. The architecture of this model consists of the vehicle damage dataset and YOLO data model. The detected damage results are used as parameters for the data frame of the vehicle damage volume level analysis model.

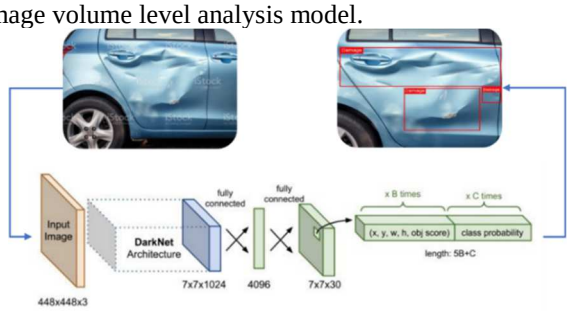

Fig. 2. Vehicle damage inspection model.

3) Vehicle Damage Classification Model: The function of the vehicle damage classification model is to detect body parts such as scratches, dents, shatters, breaks and smashed as shown in Fig. 3. The architecture of this model consists of a vehicle damage dataset and a CNN model [7]. The results of this model are used as parameters in the vehicle damage volume level analysis model.

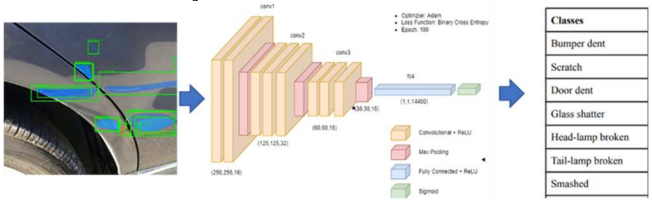

Fig. 3. Vehicle damage classification model.

4) Vehicle Damage Volume Level Analysis Model: The function of the vehicle damage level analysis model is to analyze the damage level using the type of damaged body parts, damaged part, and damaged class as shown in Fig. 4. The damage volume level is defined as level-1, level 2, and level-3, respectively. Here are two examples: First, if the damage class of scratches and dents is detected on the vehicle body part, the damage volume level is estimated to be level-3. Second, if two scratch damage classes are detected on the vehicle body part, the damage volume level is determined as Level 2. As described above, it can be seen that the damage analysis results vary according to the damage class and damage grade.

Vehicle No.	Body Part	Damage Part	Damage Class	Damage Volume Level
A	Bumper	1	Scratch	1
	Door	0	-	
	Lamp	0	-	

Vehicle No.	Body Part	Damage Part	Damage Class	Damage Volume Level
A	Bumper	1	Dent	2
	Door	0	-	
	Lamp	0	-	

Vehicle No.	Body Part	Damage Part	Damage Class	Damage Volume Level
A	Bumper	1	Scratch	2
	Door	1	Scratch	
	Lamp	0	-	

Vehicle No.	Body Part	Damage Part	Damage Class	Damage Volume Level
A	Bumper	1	Dent	3
	Door	1	Scratch	
	Lamp	0	-	

Fig. 4. Sample information of vehicle damage volume level analysis model.

IV. Conclution and Future Works

In this paper, we proposed a vehicle damage level recognition algorithm based on the CNN and YOLO model. The proposed algorithm in this paper will soon be implemented and tested to evaluate its performance. In order to implement the proposed algorithm, it is necessary to collect many image datasets, and it takes a lot of time to build and train the dataset. This study is expected to be a very useful in the field of automating the auto insurance claim process and recognizing the level of vehicle damage.

Acknowledgment

This research was supported by the MISP (Ministry of Science, ICT & Future Planning), Korea, under the National Program for Excellence in SW) supervised by the IITP (Institute for Information & communications Technology Promotion) (2018-0-018740301001).

This research was supported by the BB21plus funded by Busan Metropolitan City and Busan Institute for Talent & Lifelong Education (BIT).

References

[1] A. Shirode, T. Rathod, P. Wanjari, A. Halbe, “Car Damage Detection and Assessment Using CNN,” In Proc. 2022 IEEE Delhi Section Conference (DELCON), IEEE, pp.1-5, 11-13 Feb. 2022.

[2] K. Patil, M. Kulkarni, A. Sriraman, S. Karande, “Deep learning based car damage classification,” In Proc. 2017 16th IEEE international conference on machine learning and applications (ICMLA). IEEE, pp. 50-54, 18-21 Dec. 2017

[3] Liu, Yifan, Lu, BingHang, Peng, Jingyu, Zhang, Zihao, “Research on the use of YOLOv5 object detection algorithm in mask wearing recognition,” World Scientific Research Journal, pp.276-284, 2020.

[4] W. Zhang, et al., “Automatic Car Damage Assessment System: Reading and Understanding Videos as Professional Insurance Inspectors,” In Proc. AAAI Conference on Artificial Intelligence, vol.34 no. 09, pp.13646-13647, Apr. 2020.

[5] Min Htet Thar and Dong Myung, “A Study on Object-based Scene Recognition Algorithm using Mask Region-based Convolutional Neural Network,” In Proc. 31st Joint Conference on Communications and Information (JCCI 2021), pp.311-312, Apr. 28-30 2021.

[6] Min Htet Thar, Cheol Min Lee, Dong Myung Lee, “A Design of Traffic Accident Analysis Algorithm based on Scene Recognition,” In Proc. 2nd Korea Artificial Intelligence Conference, Korean Institute of Communications and Information Sciences (KICS), pp.363-365, Sep. 29-Oct. 1 2021.

[7] P. M. Kyu and K. Woraratpanya, Kuntpong, “Car damage detection and classification,” In Proc. 11th 2020 International conference on Advances in Information Technology (IAIT 2020), no.46, pp.1-6, Jul. 2020.