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Construction of a Vehicle Damage Level Recognition Model Based on Deep Learning

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In a traffic accident, the emergency response team, witnesses, and the occupants of the crash involved vehicle often take photographs of the damaged vehicle using cameras and drive recorders. If the level of damage to the vehicle body can be accurately analysed using the photographic images and video, it could potentially be used to make life-saving decisions for the occupants of vehicles involved in traffic accidents. In this study, a deep learning-based model for recognizing the level of damage to a vehicle was constructed for the purpose of using post-accident vehicle images for predicting occupant injuries and improving the efficiency of determining whether advanced emergency medical treatment is necessary based on the condition of the vehicle, which is important for rescue operations in the event of an accident. The model is designed to recognize the level of vehicle damage from frontal images of vehicles involved in frontal collisions. The model was constructed using vehicle damage image data extracted from data obtained in a survey of traffic accidents conducted by Nihon University and Nippon Medical School Chiba Hokuso Hospital. Three criteria for the level of vehicle damage were determined based on the Equivalent Barrier Speed (EBS): EBS<=20 km/h, 20 km/h < EBS < 50 km/h, and EBS >= 50 km/h. It was used to construct a vehicle damage recognition model based on Mask RCNN, a type of deep learning.

Figure 1 shows the overall percentage of correct responses for the three vehicle damage evaluation items calculated by the 5-ford cross-validation, as well as the percentage of true positives for each of the vehicle damage evaluation items. The overall model accuracy was very high at 85.5%. The recall of each item was sufficiently high, 97.2% and 72.3% for 20 km/h < EBS < 50 km/h and EBS >= 50 km/h, respectively.

Figure 2 shows the recognition results output when the actual EBS input 35 km/h data to the model. The input and output images, the recognized level of damage, the decision probability of the recognized level of damage, and the value of Intersection over Union(IoU) are shown respectively. The red box in the output image indicates the recognized area, and the green box indicates the area of the correct answer. The recognition content was consistent with 20 km/h < EBS <50 km/h, and the judgment probability was 99.9%. The IoU was 0.94, indicating extremely accurate recognition of the location of the damaged vehicle.

Based on the above, our model can be used as an injury prediction for occupants and as a tool to assist in judging the level of vehicle damage based on images taken by vehicle occupants, witnesses and emergency services post-crash and during rescue operations.

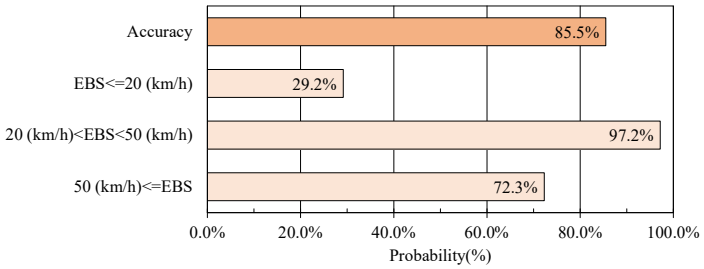

Fig.1 Verification results for accuracy and recall

	Original image	Output image	
EBS 35 (km/h)			
	Recognition details		IoU
	20(km/h)<EBS<50(km/h)	Probability 99.9%	0.94

Fig.2 Recognition results