

## **FAST DETECTION OF SEATBELT DRIVER BASED ON IMAGE CAPTURING**

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**Abstract:** Traffic accidents are one of the biggest contributors to injuries and fatalities worldwide. Victims of traffic accidents range from minor injuries to severe injuries and even death. The severity of many accidents is often due to a lack of discipline and public awareness of traffic rules and safety measures. Car manufacturers have attempted to mitigate the effects of accidents by providing seat belts. However, many people neglect to use them, thinking that nothing will happen while driving. Even with fines imposed by authorities, people can outsmart them by removing their seat belts when officers are not around. To address this issue, a model has been developed to monitor drivers using artificial intelligence and computer vision. The camera captures images, which are then processed by a neural network trained with the YOLOv5 algorithm. The model has an average precision of 89% and a recall of 81%, and can accurately detect whether drivers are wearing seat belts or not. This model is expected to aid in improving driver and passenger safety on the roads. By paying attention to the use of seat belts, the severity of injuries sustained in accidents can be reduced.

**Keywords:** computer vision; neural network; seatbelt detection; yolo

**Abstrak:** Kecelakaan lalu lintas merupakan salah satu penyumbang terbesar cedera dan kematian di seluruh dunia. Korban kecelakaan lalu lintas tidak hanya mengalami cedera ringan, tetapi juga cedera berat bahkan kematian. Parahnya banyak kecelakaan yang terjadi dapat disebabkan oleh kurangnya disiplin dan kesadaran masyarakat akan aturan lalu lintas serta tindakan keselamatan. Produsen mobil telah berusaha untuk mengurangi efek kecelakaan dengan menyediakan sabuk pengaman. Sayangnya, masih banyak orang yang mengabaikan penggunaannya, dengan menganggap bahwa tidak akan terjadi apa-apa saat mengemudi. Meskipun ada denda yang diberlakukan oleh pihak berwenang, orang masih dapat melepaskan sabuk pengaman ketika tidak ada petugas di sekitar. Untuk mengatasi masalah ini, sebuah model telah dikembangkan untuk memantau pengemudi menggunakan kecerdasan buatan dan visi komputer. Kamera mengambil gambar yang kemudian diproses oleh jaringan saraf yang dilatih dengan algoritma YOLOv5. Model ini memiliki presisi rata-rata sebesar 89% dan recall sebesar 81%, dan dapat dengan akurat mendeteksi apakah pengemudi menggunakan sabuk pengaman atau tidak. Model ini diharapkan dapat membantu dalam menangani masalah keselamatan pengemudi dan penumpang di jalan raya. Dengan memperhatikan penggunaan sabuk pengaman, dapat mengurangi tingkat keparahan cedera yang terjadi dalam kecelakaan.

**Kata kunci:** computer vision; deteksi sabuk pengaman; neural network; yolo

## INTRODUCTION

Along with the increasing human population worldwide, car production is also increasing to meet the growing demand. However, the increasing number of vehicles has also contributed to the increase in accidents, especially car accidents [1]. Traffic accidents are one of the problems that are very detrimental and require serious handling. Given the magnitude of the impact, such as loss of life, injury and property damage, efforts to prevent and reduce the number of traffic accidents need to be increased [2].

In order to reduce the adverse effects that occur due to accidents, security forces will make rules that force all drivers, both local residents and tourists, to use seat belts. If drivers wear their seat belts properly, this will help protect them from serious injury in the event of an accident. In short, seat belts can help protect drivers from the risk of fatal injury in an accident [3]. The use of seat belts is also justified by the existence of laws and regulations that require passengers in cars to wear seat belts [4].

The integration of Internet of Things (IoT) technology with the installation of seat belt sensor cameras on vehicles has a positive impact on people's lives, especially in improving traffic order in big cities. In this case, seat belt sensors in vehicles can help create smart cities that are more orderly and safer for drivers, as well as provide the ability to carry out real-time monitoring of traffic violations. This can help increase the awareness of motorists to comply with traffic rules and reduce the number of violations that occur, thereby creating a safer and more orderly city [5].

Artificial intelligence (AI) technology has been integrated in various fields, including in cameras. Today's

camera not only functions as a tool for recording and taking pictures, but can also be used as a data collection tool. The image produced by the camera will then be processed using a transformation technique to look for class classifications of detection directly [6]. In addition, the use of artificial intelligence in the camera aims to recognize the surrounding environment as well as improve the ability to analyze data and make more accurate decisions [7].

Machine learning tools are very popular and have been applied in various fields, one of which is the use of images to be used for machine recognition processes independently. Deep learning is growing fast in machine learning and convolutional neural networks (CNNs) are becoming the main tool for image analysis and classification. However, challenges such as model complexity, local deadlock issues, and over- and under-training issues remain relevant [8][9]. In addition, interpretation of the results from deep learning models is also a challenge. To address this, further research and development is required, especially for applications requiring image analysis and classification. .

There are various algorithms for predicting images using edge detection. However, under certain conditions such as similar objects or image rotation, these algorithms are less stable and accurate in making predictions [10]. Therefore, the modeling uses the YOLO neural network to predict whether the vehicle driver is wearing a seat belt or not while in the vehicle. Seat belt detection has previously been carried out using the PASCAL-VOC public dataset with the original SDD algorithm, but it has shown a slightly lower accuracy in detecting seat belts, averaging at 79.6% [11]. YOLO is a very effective technology used to detect ob-

jects quickly and the level of accuracy increases with each version. The results of the traffic sign recognition research showed that the accuracy of traffic sign detection in YOLO v3 reached 84.9%, while in YOLO v4 it reached 89.33% [12].

## METHOD

The flow of research starts from dataset collection to the frame detection model.

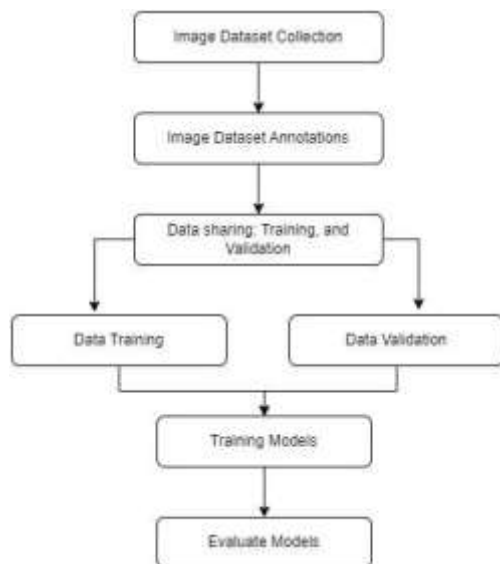


Image 1. Methodology Flow

### Collecting Data

The data used in this study is taken from a public dataset provided by the Roboflow website and supplemented with independent data collected by taking pictures from videos. A total of 595 image data were collected, divided into two different classes: images of drivers using seat belts and images of drivers not using seat belts.

### Image Pre-Processing

For this study, all images will be standardized to a size of 640 x 640 pixels by equalizing their sizes. The process of image annotation is essential to assist the model in recognizing classification targets based on the available classes [13], resulting in improved accuracy and efficiency by reducing the number of parameters and minimizing memory usage [14]. By annotating the images, the model will be better equipped to identify the various classes within them, facilitating the classification and data processing tasks.

Table 1. Table Annotation

Class	Total Annotation
Seatbelt	305
No Seatbelt	308

To increase the diversity and robustness of the image data, various augmentation techniques will be applied, such as shear, exposure, blur and noise. This technique will be used to create augmented data, which will be replicated by a factor of 2. As a result, there will be a total of 836 data samples for training, 120 data for validation, and 57 data for testing purposes. By augmenting data in this way, the model will be exposed to a wider variety of images, thereby increasing its ability to generalize to new data and be able to recognize data under various conditions[15].

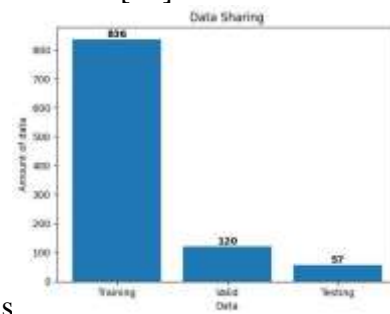


Image 2. Visualization of data sharing

### Model Training



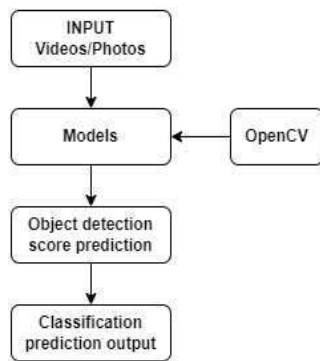


Image 4. Model Testing

## RESULT AND DISCUSSION

This section will demonstrate how the created model can carry out its duties by being able to recognize objects that are wearing seat belts and objects that are not wearing seat belts. The configuration used in YOLO has 32 batches and 157 epochs. To find out the process of processing training data with the YOLO V5 algorithm, you can see the flow of precision for each epoch in Image 5.

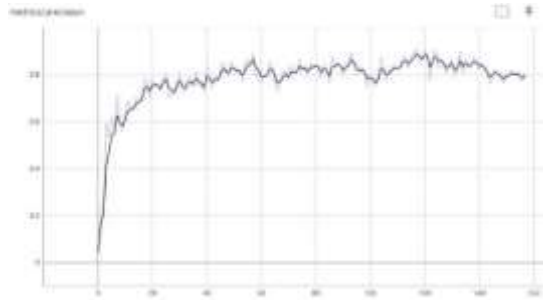


Image 5. Precision Flow

When training the model the value of precision increases from low to high, when it reaches the highest point

the graph fluctuates causing it to be unstable but the distance is not too significant. The model is good enough to detect validation objects according to the class being trained.

In addition to the precision value, there is also a recall value which has a function as a measure of the completeness of the detected object. In other words, recall is the ratio of the correct detection value to the number of algorithm detections. Image 6 is the recall flow of the training process.

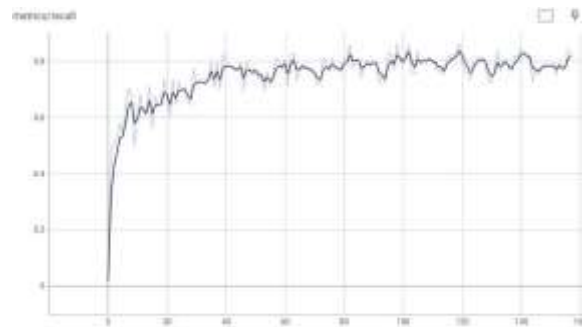


Image 6. Recall Flow

The graph on recall experiences significant fluctuations because each object is sometimes not detected in its entirety because sometimes there are 2 different objects in one image. To complete the evaluation process, another parameter will be added in the form of Mean Average Precision (mAP) to evaluate the average detection box generated by the algorithm covering the actual object. Tabel 2 shows the overall parameters of the training and validation processes.

Table 2. Table Evaluate

Class	Images	Instances	Precision	Recall	mAP
All	120	138	0.895	0.811	0.898
NoSeatBelt	120	92	0.934	0.848	0.521
SeatBelt	120	46	0.856	0.775	0.448

The calculation data above is obtained from the validation process during training. Image 7 will illustrate the confusion matrix of the training process and obtaining the data

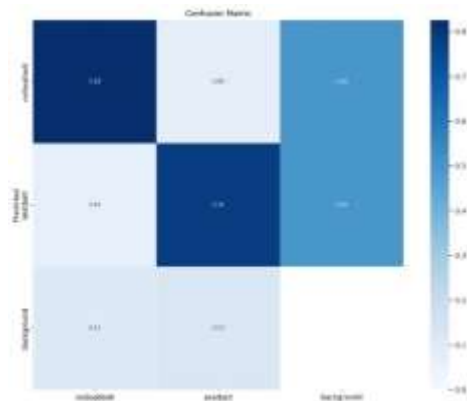


Image 7. Confusion Matrix

### Implementation

Testing of model detection is carried out using 2 methods, namely images and real time video. In this case, adding a library in the form of OpenCV because it will combine the model results from YOLOv5 with OpenCV as input. The first test is carried out by entering random images and the results will be shown in image 8.



Image 8. Detection Image

From the test using images as input, the appropriate results were obtained, namely the top image was not wearing a seat belt and was successfully detected by the machine not using a seat

belt, the image below also successfully showed wearing a seat belt. For the second test using video as input, refer to Image 9.



Image 9. Detection Video

Testing with video taken from a device camera that can retrieve the IP address. Detection in the video can run well and get an average confidence level ranging from 80%.

### CONCLUSION

In this research build a model using the neural network architecture in YOLOv5. This model serves to detect whether the driver is wearing a seat belt or not using a seat belt. The model also has a good level of accuracy during the training process with random data under various conditions. The average grade level for the whole class when training is 89% for precision and 81% for recall. Can be tested directly on hardware that has camera features when connected to the internet. The results obtained are quite effective when applied to everyday life for the monitoring process.

### BIBLIOGRAPHY

- [1] S. Sharma and S. Sebastian, "IoT based car accident detection and notification algorithm for general road accidents," *International*

- Journal of Electrical and Computer Engineering*, vol. 9, no. 5, pp. 4020–4026, Oct. 2019, doi: 10.11591/ijece.v9i5.pp4020-4026.
- [2] J. Karya and T. Sipil, “ANALISIS KECELAKAAN LALU LINTAS (STUDI KASUS-JALAN RAYA UNGARAN-BAWEN),” Halaman, 2014. [Online]. Available: <http://ejournal-s1.undip.ac.id/index.php/jkts>
- [3] D. Bhupal Naik, G. Sai Lakshmi, V. Ramakrishna Sajja, D. Venkatesulu, and J. Nageswara Rao, “Driver’s Seat Belt Detection Using CNN,” 2021.
- [4] A. Giubilini and J. Savulescu, “Vaccination, Risks, and Freedom: The Seat Belt Analogy,” *Public Health Ethics*, vol. 12, no. 3, pp. 237–249, Nov. 2019, doi: 10.1093/phe/phz014.
- [5] M. K. Almohsen, R. K. Alonzi, T. H. Alanazi, S. N. Binsaf, and M. M. Almujaal, “Smart Car Seat Belt: Accident Detection and Emergency Services in Smart City Environment,” in *2021 1st International Conference on Artificial Intelligence and Data Analytics, CAIDA 2021*, Institute of Electrical and Electronics Engineers Inc., Apr. 2021, pp. 109–114. doi: 10.1109/CAIDA51941.2021.9425108.
- [6] Y. Rong, C. Han, C. Hellert, A. Loyal, and E. Kasneci, “Artificial Intelligence Methods in In-Cabin Use Cases: A Survey,” *IEEE Intelligent Transportation Systems Magazine*, vol. 14, no. 3, pp. 132–145, 2022, doi: 10.1109/MITS.2021.3050883.
- [7] IEEE Computer Society. and Institute of Electrical and Electronics Engineers., *ASAP 2018: 2018 IEEE 29th International Conference on Application-specific Systems, Architectures and Processors (ASAP): Milan, Italy, 10-12 July 2018*.
- [8] C. Tian, L. Fei, W. Zheng, Y. Xu, W. Zuo, and C. W. Lin, “Deep learning on image denoising: An overview,” *Neural Networks*, vol. 131, Elsevier Ltd, pp. 251–275, Nov. 01, 2020. doi: 10.1016/j.neunet.2020.07.025.
- [9] Institute of Electrical and Electronics Engineers, *2018 International Interdisciplinary PhD Workshop (IIPhDW): 9-12 May 2018*.
- [10] A. Kashevnik, A. Ali, I. Lashkov, and N. Shilov, “Seat Belt Fastness Detection Based on Image Analysis from Vehicle In-cabin Camera,” 2020.
- [11] D. Wang, “Intelligent Detection of Vehicle Driving Safety Based on Deep Learning,” *Wirel Commun Mob Comput*, vol. 2022, 2022, doi: 10.1155/2022/1095524.
- [12] C. Dewi, R. C. Chen, Y. T. Liu, X. Jiang, and K. D. Hartomo, “Yolo V4 for Advanced Traffic Sign Recognition with Synthetic Training Data Generated by Various GAN,” *IEEE Access*, vol. 9, pp. 97228–97242, 2021, doi: 10.1109/ACCESS.2021.3094201.
- [13] N. Mamat, M. F. Othman, R. Abdulghafor, A. A. Alwan, and Y. Gulzar, “Enhancing Image Annotation Technique of Fruit Classification Using a Deep Learning Approach,” *Sustainability (Switzerland)*, vol. 15, no. 2, Jan. 2023, doi: 10.3390/su15020901.
- [14] F. Tian, W. Ma, and F. Tan, “Improved YOLOv5 model for rice stem and leaf lesion image annota-

- tion.” [Online]. Available: <https://ssrn.com/abstract=4212342>
- [15] R. Dulal *et al.*, “Automatic Cattle Identification using YOLOv5 and Mosaic Augmentation: A Comparative Analysis,” 2022.
- [16] G. Yang *et al.*, “Face Mask Recognition System with YOLOV5 Based on Image Recognition,” in *2020 IEEE 6th International Conference on Computer and Communications, ICCCC 2020*, Institute of Electrical and Electronics Engineers Inc., Dec. 2020, pp. 1398–1404. doi: 10.1109/ICCC51575.2020.9345042.
- [17] G. Guo and Z. Zhang, “Road damage detection algorithm for improved YOLOv5,” *Sci Rep*, vol. 12, no. 1, Dec. 2022, doi: 10.1038/s41598-022-19674-8.
- [18] Z. P. Xu, Y. Zhang, J. Cheng, and G. Ge, “Safety Helmet Wearing Detection Based on YOLOv5 of Attention Mechanism,” in *Journal of Physics: Conference Series*, IOP Publishing Ltd, Mar. 2022. doi: 10.1088/1742-6596/2213/1/012038.
- [19] Institute of Electrical and Electronics Engineers. Bangladesh Section, IEEE Region 10, and Institute of Electrical and Electronics Engineers, *2020 IEEE Region 10 Symposium (TENSYP) : 5-7 June 2020, Dhaka, Bangladesh*.