Reference	*CP64*
Project Title	Risky Scenario Identification
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Confidentiality	

Contents

Summary

This study aimed to determine whether perceived risk, as rated by a large group of human participants, could be predicted from basic features extracted using computer vision. To achieve this, we developed a framework for estimating perceived traffic risk in various traffic scenes, encompassing diverse scenarios. By employing computer vision techniques, we quantified the information in the images, such as the number of vehicles and their distances. Using a random forest regression model, we built a prediction model to assess risk perception, aiming to distinguish safety between different traffic scenarios. The complete framework is illustrated in Figure 1.

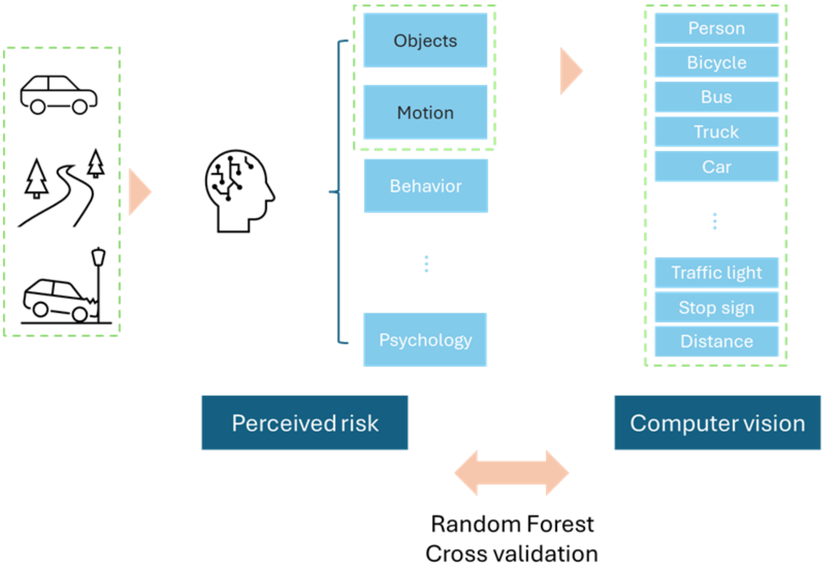

Figure 1. Framework of Risky Scenario Identification

TITLE

1. Background

As autonomous vehicles (AVs) become more integrated into modern transportation systems, assessing perceived risk in various traffic scenarios is critical for enhancing safety and public trust. Perceived risk refers to how individuals evaluate the potential danger in a given situation, which can influence both human and AV driving decisions. Traditional approaches to estimating risk rely heavily on manually annotated data, which may not fully reflect real-world conditions encountered by AVs. Leveraging advancements in computer vision, particularly object detection models, offers a more scalable and realistic way to assess traffic scenes. This study investigates whether features automatically extracted from traffic images can predict perceived risk in a way that aligns with human judgments, contributing valuable insights for improving AV safety and navigation.

2. Project set up

2.3 Purpose

The purpose of this study is to develop a model that can accurately predict perceived risk in traffic scenarios using basic features extracted from images through computer vision. By employing an automatic object detection method, the study aims to better reflect real-world conditions and demonstrate how perceived risk can be quantified in diverse traffic environments. This work ultimately seeks to contribute to safer and more reliable autonomous vehicle systems by understanding how humans perceive risk.

2.4 Objectives

- To apply computer vision techniques, specifically the YOLOv8 model, to automatically detect relevant objects (such as vehicles, pedestrians, and traffic signs) in the images.
- To develop a random forest regression model to predict the perceived risk based on the detected objects and vehicle speed.
- To evaluate the predictive accuracy of the model and compare it with human risk perception in various traffic scenarios.

2.5 Project period

2023-05-01 - 2024 -09-30

2.6 Partners

Chalmers, RISE, Alkit Communications

3. Method and activities

The project employed computer vision techniques and machine learning to predict perceived risk in traffic scenarios.
The key methods included:

- Data Collection: Traffic scene images were sourced from the KITTI dataset, and human participants rated the perceived risk in each image on a scale from 1 to 100.

- Object Detection: YOLOv8, an advanced object detection model, was used to automatically identify and classify objects in the images, such as vehicles, pedestrians, and traffic signs, without relying on manually labeled data.
- Feature Selection: Relevant features such as object distance, class (e.g., cars, trucks, pedestrians), and vehicle speed were extracted and analyzed.
- Model Development: A random forest regression model was developed to predict perceived risk based on the extracted features.
- Evaluation: The model's predictive accuracy was assessed by comparing its outputs with human ratings, demonstrating how well the model could replicate population-level risk perception.

These activities allowed the project to explore how automated tools can contribute to predicting human-like perceptions of risk in traffic environments.

4. Results and Deliverables

Images depicting different traffic scenarios were taken from the KITTI dataset[1], and 210 images were selected for evaluation by 1,918 respondents[2], who rated the perceived risk on a scale from 1 to 100. Computer vision techniques were applied to detect objects in these images. Instead of relying on the manually labeled bounding boxes provided by the KITTI dataset, we opted for a widely available method for automatic object detection to better reflect the capabilities of autonomous vehicles. Specifically, a YOLOv8 model[3] was used to extract instances of objects belonging to certain classes, identifying up to 80 different object categories. For this analysis, only the distances and classes relevant to traffic were retained: Person, Bicycle, Car, Motorbike, Bus, Train, Truck, Traffic light, and Stop sign as shown in Figure 2. A random forest approach was then employed to model the perceived risk based on the quantified traffic scenarios.

Figure 2. YOLOv8 identification

The study demonstrated that computer vision outputs can accurately predict population-level perceived risk in static images of traffic scenes. The model's predictive accuracy, based on the number of people, vehicles, and traffic signs, was found to be r = 0.59. When speed information was incorporated, the accuracy increased to r = 0.74. These results suggest that basic features extracted from camera images, when combined with standard vehicle-state information (such as speed), can enable a relatively strong prediction of perceived risk at the population level. These findings align with previous research indicating that computer algorithms can predict various human behaviors and traits.

5. Conclusions, Lessons Learnt and Next Steps

- Real-Time Estimation: The results of this project demonstrate that it is feasible to estimate perceived risk in real-time using computer vision techniques. By automating the detection of key features (such as vehicles, pedestrians, and traffic signs) from traffic images, autonomous vehicles can make quick risk assessments on-the-go. This capability has great potential for future projects aimed at improving the safety and responsiveness of AVs in dynamic, real-world traffic scenarios.
- Risk-Sensitive Speed Adjustment: The project findings suggest that combining perceived risk estimation with vehicle speed can enable more proactive safety measures. For instance, if a high perceived risk is detected in a given scenario, AVs could autonomously adjust their speed to mitigate the risk and provide a safer experience. This approach, integrating real-time risk prediction with adaptive speed control, could be a vital step in developing smarter, safer autonomous vehicles that respond more effectively to complex traffic situations.

6. Dissemination and Publications

There are currently no publications, but there are plans to organize and publish the findings in the near future.

7. Acknowledgement

Reference

[1] Geiger, A., Lenz, P., Stiller, C., & Urtasun, R. (2013). Vision meets robotics: The kitti dataset. The International Journal of Robotics Research, 32(11), 1231-1237.
[2] de Winter, J., Hoogmoed, J., Stapel, J., Dodou, D., & Bazilinskyy, P. (2023). Predicting perceived risk of traffic scenes using computer vision. Transportation research part F: traffic psychology and behaviour, 93, 235-247.
[3] Li, Y., Fan, Q., Huang, H., Han, Z., & Gu, Q. (2023). A modified YOLOv8 detection network for UAV aerial image recognition. Drones, 7(5), 304.