

学 位 論 文 の 要 旨

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学位論文題目 A Study on Road Surface Marking Quality Evaluation Using Machine Learning and Computer Vision (英訳 機械学習とコンピュータビジョンによる路面標示評価に関する研究)			
<p>In today's fast-growing cities and with new advances in computer learning, there's a big need for better traffic systems. One important part of this is the condition of road markings. These markings help guide traffic and keep roads safe. But over time, they can fade or get damaged, which can be a problem. This research looks closely at this issue, especially in the Mie area of Japan.</p> <p>At the heart of this study is a big collection of 13,000 clear pictures, sized 3000x1600, from the local government of Mie. These pictures show many kinds of roads and places where roads meet, in both busy cities and quiet countryside areas. The pictures were taken in different light settings and show many things like bright sun effects, long shadows, old roads, and different traffic signs. This big collection of pictures gives a full view of the road conditions but also brings many challenges in studying them.</p> <p>To help with these challenges, the study used computer learning. A helpful tool was made to make the job of labeling pictures easier. With this tool, 400 pictures were labeled, and these labeled pictures were used to train a computer model called U-Net. This model did well, getting a score of 78.90%. But there was more to do.</p> <p>Using the trained U-Net model, more pictures were labeled quickly. In the end, 12,000 pictures were labeled. However, about 1,000 pictures were filtered out manually because they were incorrectly labeled by the trained model.</p> <p>Using this dataset, we were able to publish a paper that presents a comprehensive survey of various segmentation models to assess their applicability and performance on the task of segmenting road surface markings, which is crucial for advancements in self-driving cars and road safety. We trained and tested multiple segmentation models including FCN, U-Net, PSP-Net, DeepLabV3, Mask-RCNN, Seg-Net, and LinkNet. The results highlighted U-Net models as particularly effective, based on their Dice score evaluations, indicating their potential for improving traffic landmark segmentation tasks.</p>			

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A significant achievement of the study was identifying and analyzing the road markings. This was accomplished through a combination of conventional image analysis techniques and innovative computer learning methods. We developed a new model called "Efficient VGG-16," which is a modified form of a well-known model called VGG-16. The model was effective in assessing the quality of road markings and achieved an MSE score of 3.62%, indicating its high performance.

We also managed to present an innovative approach to automating the evaluation of road surface markings' quality using Uncertainty Aware (UA) regression combined with deep learning techniques. By converting RGB images into binary masks and employing data augmentation, the study utilizes Convolutional Neural Networks (CNNs) trained with a novel training strategy which we call the “Progressive Pretraining (PPT)” strategy. The approach significantly outperforms the baseline model in metrics such as Mean Average Error (MAE) and accuracy, demonstrating the benefits of integrating UA methods and progressive learning for quality assessment tasks. This method not only enhances the reliability and precision in assessing road markings but also sets a precedent for applying UA regression in broader quality evaluation contexts, potentially improving automated systems for infrastructure evaluation and supporting advancements in autonomous driving technologies.

Looking forward, the study has many plans. It wants to use new ways to make checking the quality of road markings even better. It also wants to use recent techniques such as diffusion to improve the quality evaluation results. Another idea is to use a method called PhyCV edge detection. This will make finding and checking road markings even better.

This research provides significant insights into the maintenance of road markings and their impact on road safety. The study used advanced computer learning techniques to analyze a dataset of 13,000 images and achieved commendable accuracy. The study also introduced new methodologies for refining the quality evaluation of road markings, paving the way for future advancements in autonomous driving technologies and road safety measures. Through this research, we can create more efficient and safe traffic systems for the fast-growing cities.