Project Proposal: Multi-Frame Image Registration for License Plate Enhancement

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1 Problem

Dashboard cameras and car-mounted surveillance systems often fail to capture clear license plate images due to motion blur, low resolution, lighting conditions, and lens distortion (Shashirangana et al., 2021). Enhancing license plate recognition (LPR) is crucial for police investigations, traffic monitoring, and automated vehicle tracking, many of which utilize automated LPR using optical character recognition (OCR). Current single-frame image enhancement techniques struggle to recover fine details in blurry or overexposed conditions. This project will compare three different multi-frame image registration (IR) techniques to align and fuse multiple frames from a video to reconstruct a clearer image. This approach is beneficial in security applications, toll booths, and even commercial dashboard cameras where identifying a license plate is critical.

2 Related Work

Many papers on LPR focus on automated LPR, and only focus on improving OCR rather than improving license plate localization from multiple frames. However, Cui and Huang (1997) present a method for extracting, tracking, and binarizing license plate characters from moving vehicles to improve recognition accuracy. They utilize IR to track and align license plates across frames, correct perspective distortion, and enhance text clarity. In addition, Suresh et al. (2007) use IR to align multiple subpixel-shifted low-resolution frames of a moving vehicle's license plate, enabling multi-frame super-resolution to improve readability.

3 Method

Dataset This project requires a dataset containing multi-frame sequences of the same license plate captured under different conditions. Each sequence should have at least 5-10 consecutive frames where the license plate is visible. The dataset should include: Motion blur, lighting variation, lens distortions, different angles & perspectives, and real-world dash cam footage.Possible sources include the Audi autonomous driving dataset (A2D2) (Geyer et al., 2020) or custom data from publicly available dash cam footage.

The images will be pre-processed to extract license plate frames and normalize brightness/contrast.

Image Registration Methods To align consecutive frames of license plates captured from moving vehicles, this project will compare three different IR techniques. Feature-based registration (ORB) detects and matches keypoints across frames, followed by RANSAC-based homography estimation to align images. Intensity-based IR will be compared using optical flow, which allows for fine-grained alignment by estimating the pixel-wise motion between consecutive frames. Finally, if computational resources allow, deep homography estimation will be explored using a neural network to directly predict the transformation between frames, potentially offering improved robustness in challenging conditions like motion blur and lighting variations.

Frame Merging After IR, multiple aligned frames will be combined using either averaging or super-resolution, depending on resource availability. Pixel-averaging provides a simple way to reduce noise, but it may blur fine details if the alignment is imperfect. Multi-frame super-resolution (MFSR), uses multiple registered frames to reconstruct high-resolution details, improving the clarity of text for OCR. Classical approaches such as bicubic interpolation may be used for upscaling.

Evaluation To measure the effectiveness of the IR process, these metrics will be used: Structural similarity index (SSIM), peak signal-to-noise ratio (PSNR), OCR accuracy improvement, and visual comparison,

4 Significance

This project will demonstrate how multi-frame IR can enhance license plate readability in real-world surveillance and traffic monitoring applications, and which IR method is most effective.

References

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