Image Processing in Law Enforcement

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Introduction

Digital image processing deals with performing mathematical operations upon digital images to enhance them and extract useful information.

It has been used for decades in law enforcement and the first notable occurrence was with the video recording of President John F. Kennedy's assassination. The footage caught on an 8 mm Bell and Howell camera was vital to the investigation of the assassination and needed to be processed. From there, technology has continued to advance and allow investigators to analyze video footage further.

In recent years, advanced image processing techniques have been gaining more and more exposure as they are seen frequently in crime shows/movies. Similarly, they have become more common and an absolute necessity in real life law enforcement and criminal investigations.

Digital images gathered from security cameras tend to have poor quality due to long distances, weather, or nightfall. Without enhancing security camera images, investigators would never be able to ID persons or objects of interest in a crime. They would never be able to determine a crimanal's direction and speed. They would never be able to classify a license plate number. The following project will examine how law enforcement processes security camera footage to use in their criminal investigations.

Pre-Processing

1. Noise Reduction

Noise reduction is the process of removing noise from a signal. In this case the image on the right is much smoother and clearer than the one on the left.
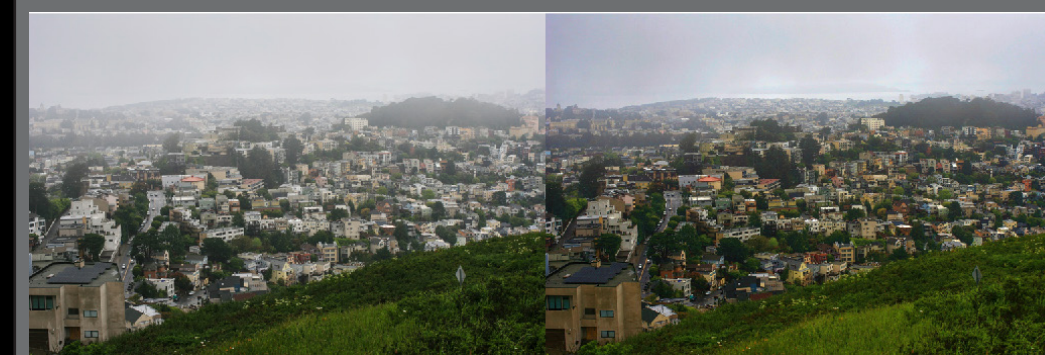
2. Haze Reduction

Haze reduction, similar to noise reduction, is the process of removing haze from a signal that may be caused by the distances of part of the image, poor lighting, or weather such as fog or rain.

3. Color Enhancement

Color enhancement is the process of taking a lowlight image and adding a color map from another image to brighten it. People and colors are made out much better in the bottom image.

Edge Detection

Edge detection is an image processing technique for finding the boundaries of objects within an image. It finds the discontinuities in brightness. In law enforcement, edge detection can help identify objects in security cameras. In this case, laplacian edge detection was used to extract the license plate.

Segmentation
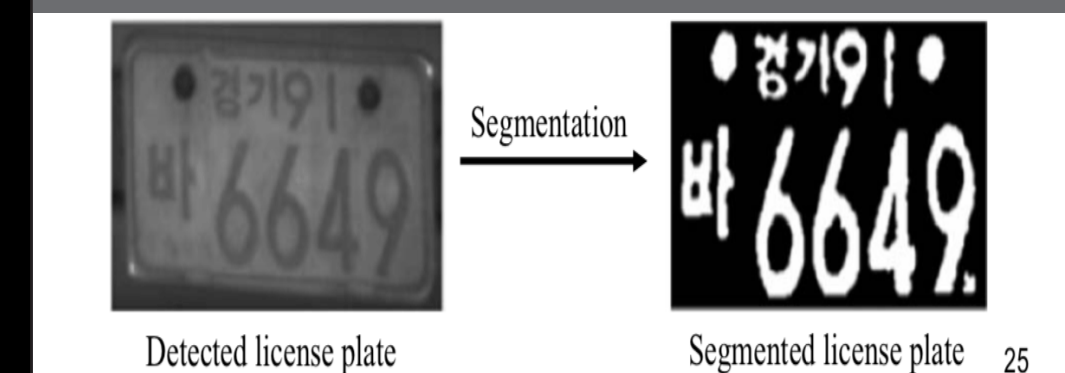
Detected license plate → Segmented license plate 25

Image segmentation is the process of dividing a digital image into multiple segments. Its goal is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. In the image above, a detected license plate is segmented to show only the important information, which in this case, is the numbers/characters.

Application

One of the most common applications of processed images in law enforcement is to detect the movement of a person or car for instance. Movement detection can be performed in two different ways; Subtracting two successive video frames or subtracting the current frame from the reference frame. The first approach is preferred as it does not require adjusting for camera movements and lighting changes.

Movement detection tracing the person's path and speed.

Another common application of processed images is extracting license plate information. Several algorithms such as plate localization, character segmentation, and optical character recognition are performed on the captured image. These algoritms can provide law enforcement with a license plate number they could not easily make out in security footage.
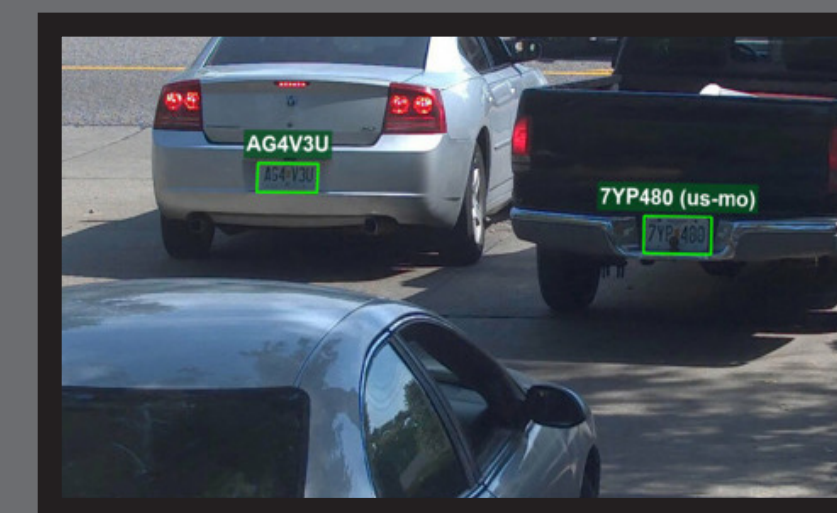
License plate detection and extraction.

Conclusion

Surveillance cameras are everywhere: banks, hospitals, schools, businesses, homes, streets, etc. Therefore, video footage is one of the first pieces of evidence searched for in an investigation. As seen in this project, video footage can be processed/enhanced to determine a person's path and speed and to detect/classify license plates.

However, digital image processing is used even further in the field of law enforcement. It can be applied to fingerprints, retinal scans, shoe impressions, vehicle impressions, etc.
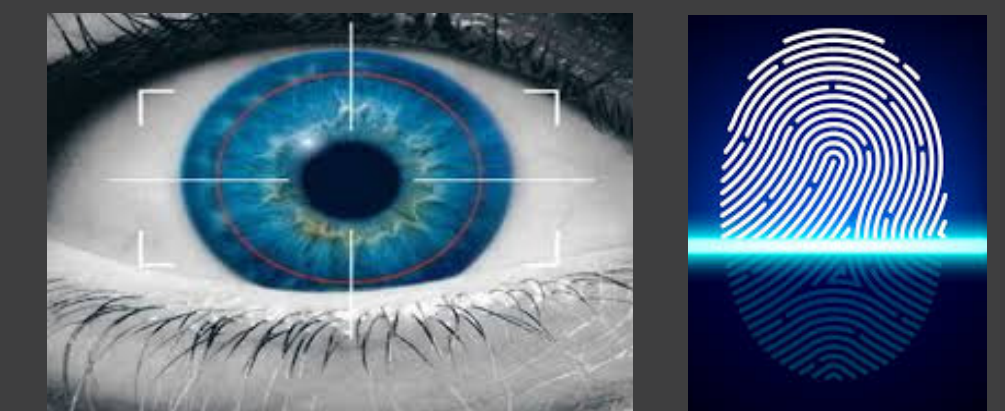
Like any technology, there are limitations to image enhancement of security camera image enhancement. For example, a subject's facial features may not be extracted from an image if the surveillance camera was a daytime system and the images captured were low-light night images. No amount of image processing/enhancement can add information that is not already in the image.

As security cameras continue to advance, so will the use of digital image processing in law enforcement. This will further the debate over privacy vs security. Do we really want to continue pushing the limits of image processing at the expense of our privacy?