**License Plate Detection Using Artificial Intelligence**

Alice Ji and Michelle Liu

Thomas Jefferson High School for Science and Technology

Computer Systems Research Lab

Dr. Gabor and Dr. Osborne

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**Abstract**

Low-resolution traffic security cameras often yield blurry, undecipherable videos, which makes it difficult to track down cars. Although it is hard for humans to decipher blurry security camera footage, computer algorithms can offer assistance. There is already existing free technology that can read license plate numbers off an image, but it only works on clear closeup images. Others are expensive or can only extract information from a single image. This project takes a short clip of a fast-moving car as an input and outputs the license plate numbers. First, YOLOv5, a real-time object detection system, is used to identify where the license plate is on the first frame of the video. Then, super-resolution tracks the license plate throughout the video and pieces all the frames together into one single image. Preprocessing filters remove noise, sharpen the image, and increase the contrast, and finally, Pytesseract optical character recognition reads the characters in the image. Each step is run through a webpage user interface that displays the output after each step.

**Introduction**

Security cameras have a variety of uses, ranging from enforcing traffic surveillance, managing parking systems, and providing video evidence of crimes. However, footage can sometimes be too blurry for human eyes to read. There are free license plate reading apps and websites, but they rarely provide a good reading, and expensive security cameras that can read license plates can cost hundreds to thousands of dollars. Our goal is to create a free website or app that can identify license plates in images or videos with higher accuracy compared to other free methods.

Over the past decade, text detection has evolved to detect horizontal text, multi-orientation, multilingual, curved text, and arbitrary-shaped text (Rainarli et al., 2021). However, text detection and recognition in poor-quality videos still remains a challenging problem (Khare et al., 2016). Image deblurring is difficult not only because of camera movement but also object motion and abrupt variations in depth (Li et al., 2021). Most existing methods involve sophisticated image capture devices, fixed rotation angles, or controlled translation, but real-world scenarios are unconstrained and dynamic, and they often contain similar background objects, occlusion, motion blur, and non-uniform illumination. (Zhang et al., 2021) Because of this, simple algorithms may not work well in complex environments.

Guarnieri et al. (2021) and Zhang et al. (2021) were able to extract information from multiple frames in a video in order to generate a clear image. According to Guarnieri et al. (2021), single blurry images are often unreliable for license plate recognition. Multiple images should give more accurate results since video sequences provide more effective information than individual frames. In addition to reading text, artificial intelligence (AI) can also determine the region that a license plate belongs to. Omar et al. (2020) achieved this by separating Arabic license plates into three sections containing a plate number, a city region, and a country region.

**Methods**

The project uses multiple frames of a video to improve the performance of our license plate detection AI compared to existing free algorithms. We will also create a website or app so that our AI is accessible to the public, and we may also try to classify the state or country that a license plate belongs to. The four major steps will be combining the frames, detecting the position of license plates, preprocessing the image, and recognizing the text.

The first step in our process is to take a motion-blurred image or video and generate a clear image. This can be achieved through machine learning, but in order for the machine to learn, we need a dataset of blurred and clear license plate image pairs. By training the machine learning model on this dataset, it will learn how to predict the clear version of an image when provided with the blurred version. In order to create this dataset, we will acquire a large set of license plate images from the internet, and then we will artificially apply a motion blur filter to each image, which will make the license plates appear as if they are moving at a fast speed.

Next, we have to first identify where the license plate is within the image. YOLOv5 is a family of object detection models that can quickly identify where an object is within an image. After determining where the license plate is, we can crop out everything else. The text detection algorithm will only need to focus on the license plate itself, as opposed to an entire image of a car.

Before reading the text, we will apply preprocessing filters that sharpen the image and increase the contrast. By doing this, we can improve the performance of the text recognition algorithm. There are three main filters: denoising, deblurring, and binarization. The denoising filter removes black and white speckles that sometimes appear in security camera footage, and the deblurring filter sharpens the edges of slightly blurry images. Finally, the binarization filter converts every pixel in the image to black or white, which greatly increases the contrast. The result is a sharp, high-contrast image that produces much better text detection results compared to the original.

Once the preprocessing is finished, we can use optical character recognition (OCR) to read the text on the license plate. The OCR splits the license plate image into characters and places a box around each one. The preprocessing filters from the previous step help a lot with making the characters look more distinct from each other. Next, the OCR reads each character and outputs a string of letters and numbers that should represent the text on the license plate.

We plan on first focusing on only reading United States license plates, but a possible extension would be to detect international characters and identify the country that the license plate belongs to. This will help especially in third-world countries, where unregistered vehicles are a major issue. Another possible extension would be to classify U.S. license plates into the states that they belong to. This method may also increase accuracy; if the OCR misreads the text, identifying the state may help narrow down the possibilities.

**Results**

Currently, the preprocessing filters are finished, although the denoising filter will decrease the quality of the image when there is no speckled noise, which is usually the case. However, when there is noise, the denoising filter is a major improvement. This means that it may be beneficial for us to first determine whether there is noise in an image, and then only apply the denoising filter if necessary. As for the OCR, it works most of the time, but it has a lot of room for improvement. It sometimes mistakes similar characters for each other, such as “1” and “I”, or “5” and “S”. The first pair can be avoided since Virginia doesn’t use “I”, “O”, or “Q” in license plates, but the second pair is an issue that we will have to address, especially since deblurred characters can appear more rounded or distorted. One way to improve the OCR would be to train it with U.S. license plate fonts, which can be purchased online.

Although machine-learning-based deblurring can be a beneficial step for forensic video processing, the use of artificial intelligence should still be treated with caution (M. Fontani, personal communication, Jan. 11, 2022). Neural networks are biased towards that data that they are trained with, and it is hard to precisely explain how they work. Because of this, our application should not be used to analyze data to be presented as evidence in court, though it may be acceptable as a tool to get investigative leads. Ultimately, our goal is to work towards an open-sourced, free application that is easily accessible for general use in everyday scenarios.

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