

This document gives some guidelines for image quality and setting up cameras in systems using LPR.

## Camera positioning

- The camera should be mounted in such a way that in the resulting image of a single line license plate a horizontal line can be drawn which crosses both the left edge and the right edge of the license plate.

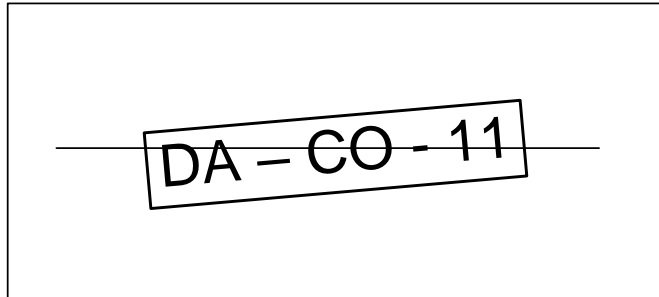


Figure 1 Camera view angles ok

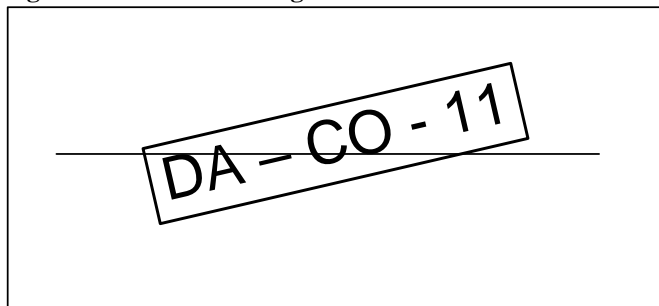
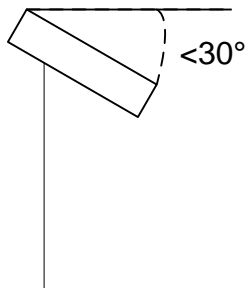


Figure 2 Camera view angles too big

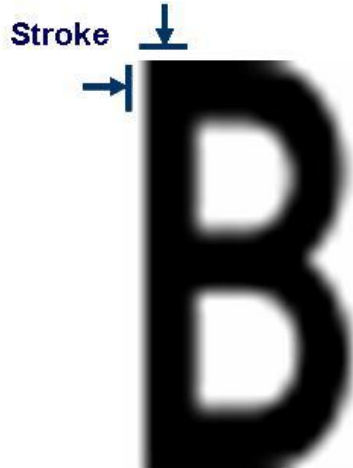
- Mount the camera in such way that an ideal image of the license plate is captured when the license plate is in the center of in the recorded image.
- The maximum vertical view angle of an LPR camera is 30 degrees.



- The maximum horizontal view angle of an LPR camera is 25 degrees. In most systems the horizontal angle is somewhere between 15 and 20 degrees.
- Avoid possible blocking objects in the view path of the camera such as (moveable) bars.

## License plate resolution

- For resolution we always use the term pixels per stroke to define a minimum requirement for LPR. The image below shows what is meant with stroke. Because the thickness of strokes is country and plate style dependent we do not use pixels/cm. The resolution for best LPR performance should be at least 2.7 pixels/stroke.



For single line US plates (width 30.5cm, stroke width around 0.7 cm) this typically means that the plate width has to be at least 130 pixels.

For single line European style plates (width 52cm, stroke width around 1 cm) this typically means a plate width of at least 170 pixels.

- When vehicles are moving when recorded for LPR and an interlaced camera is used then only a half image can be used (only the even lines). This means that the resolution requirements almost have to be doubled.

For single line US plates (width 30.5cm, stroke width around 0.7 cm) this typically means that the plate width has to be at least 215 pixels.

For single line European style plates (width 52cm, stroke width around 1 cm) this typically means a plate width of at least 280 pixels.



Figure 3 Interlaced image of a moving car

## License plate contrast

- For contrast we use the difference in gray value (when image is converted to grayscale) between the characters at the license plate and the license plate background. This difference should be at least 15.



contrast ok



recognition still possible



contrast too small

## License plate focus (lens and shutter speed issues)

- The license plate should be in focus when the image is used for LPR.
- When using an auto-iris lens always set the focus with the aperture as open as possible. To make the aperture open ND filters can be used or, when the camera supports manual setting the shutter time, the shutter time can be set too a short time.
- When using an infrared light source note the focus shift when switched between visible light and infrared light. The focus shift can be avoided by using an infrared compensated lens or using an infrared pass filter. When using an infrared pass filter, also during daytime an infrared light source is needed.
- When vehicles are moving when recorded for LPR the shutter time off the camera should be set to a shutter time which is short enough to avoid motion blur. The rule to determine the longest allowed shutter time is:  

$$\text{shutter time in seconds} = 1 \text{ second} / (11 * \text{max vehicle speed in km/h})$$

$$\text{shutter time in seconds} = 1 \text{ second} / (18 * \text{max vehicle speed in miles per hour})$$

shutter time in seconds	Max. speed in km/h	Max. speed in m/h
1/50	4	2
1/100	9	5
1/200	18	11
1/250	22	13
1/500	45	27
1/750	68	41
1/1000	90	55
1/1500	136	83
1/2000	181	111
1/3000	272	166
1/4000	363	222

## Other image quality interfering camera issues

- One of the most common image interference caused by the camera is gain noise. For LPR systems it is recommended to set auto gain functionality off or gain as low as possible. Gain noise is also avoided when your external lighting in dark environments is sufficient.

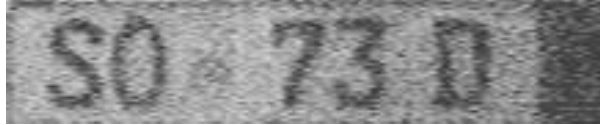


Figure 4 License plate image with gain noise

- Some cameras use a contour, edge or contrast enhancement algorithm to make the image look better for the human eye. These algorithms can interfere with the algorithms in the LPR software. It is recommended to disable these kinds of algorithms in the camera setup when possible.
- Some cameras compress the recorded image with some kind of compression algorithm, e.g. jpeg. High compression rates influence the license plate image quality. When a high compression rate is used more license plate resolution is needed to get the same LPR performance. Jpeg save quality above 80% has almost no negative influence on LPR performance when image has normal resolution, contrast, focus and low noise.



Figure 5 a) Low compression - jpeg 80% b) high compression - jpeg 50%

## Lighting issues

- Too many environmental lighting can cause overexposure or smear. To avoid overexposure it is recommended to use a camera with a high dynamic range and/or use an auto iris lens. Another often used way to exclude difficult environmental lighting condition is to use artificial infrared lighting combined with an infrared sensitive camera with an infrared pass filter. License plates which are very suitable for use with infrared lighting are so called retro-reflective license plates. The background of this kind of license plate is made of special reflective material.

Note that cameras with a CMOS imager are less sensitive to smear than cameras with CCD imagers. In general CCD imagers with a bigger surface are less

sensitive to smear than CCD imagers with a smaller surface.



**Figure 6 Smear**

- Too less environmental or external lighting causes underexposure. When auto gain can't be disabled or when there can't be set a maximum allowed shutter time with moving vehicles too less light first causes respectively gain-noise and motion blur in the image before underexposure (too less contrast). Underexposure can be avoided by using sufficient external lighting and/or using a camera with good sensitivity in low light environments without using gain. In general cameras with larger imagers are more sensitive for light than cameras with smaller imagers.

### **General issues to note when choosing a camera for LPR**

- LPR differs from CCTV. For example a CCTV company always desires the best visible overall image for a human, when choosing and setting up a camera for LPR only the small part of the image containing the license plate is important. Generally there are some basic features which should be kept in mind when choosing a camera for LPR.
- Resolution - Choose a camera with enough resolution.
- Dynamic range – This determines for example the sensitivity in low/high light conditions and the reaction features in changing light conditions and also the sensitivity for Infrared lighting.
- Ability to set a shutter speed fit for your situation.
- Ability to switch off image enhancement techniques such as auto-gain and contrast/contour enhancement. It is recommended to use an image as raw as possible with LPR.
- Also a camera needs a lens. A lens should be suitable for your camera (resolution) and your external lighting condition. For example when infrared lighting is used it is preferred to also use a lens with an infrared pass filter or at least a lens which is compensated for infrared light, otherwise you get a focus shift when it is getting dark. To get a better dynamic range for your camera it is sometimes recommended to use a lens with an auto iris.