LPR
Camera installation
Manual

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EVA (External Video Analytics)

LPR Camera Installation v1.0.0

1. Introduction

This white paper describes the fundamental principles of the automatic vehicle license plate recognition system and the key aspects of choosing, installing, and configuring video cameras for efficient automatic license plate capture and recognition.

2. Main Definitions and Objectives

Automatic Number Plate Recognition (ANPR) - License Plate Recognition (LPR) is a versatile technology that is currently indispensable for solving most problems in the road transport sector.

These include, for example, access control, toll collection, law enforcement, and license plate tracing.

As a rule, industrial cameras with a real-time shooting function are used for this purpose. If the camera is equipped with a suitable sensor (image sensor), it has sufficient sensitivity to obtain high quality images even with fast shutter speeds.

Different terms are used for ANPR systems:

- License Plate Recognition (NPR), (LPR)
- Automatic Vehicle Identification (AVI)
- Car Plate Recognition (CPR)

The main task of LPR is to automatically extract vehicle license plate characters from the image received from CCTV cameras for further processing by the security system.

A detailed list of tasks solved by the LPR system:

1. Recognition of state registration plates.
2. Detection of vehicles in the control area, determination of the directions of their movement and the fact of entry/exit.
3. Records in the archive of information about passing cars, information output in real-time.
4. Search in the archive of detected license plates by a set of features, uploading the recognition history.
5. Keeping a card index of car numbers, with the ability to link additional fields to the number (information about its owner).
6. Grouping number cards to create lists of interception, opening a barrier, and other automatic reactions according to a scenario.
7. Receiving data from truck scales.

Automatic Vehicle License Plate Recognition has many applications, including access control, parking management, and high-speed highway toll collection.

2.1. Composition and Principle of Operation

The LPR system consists of software that captures an image, locates the location of the number on the image, and then extracts letters and numbers using character recognition algorithms that digitize pixels that can be understood by standard computer file systems. The input data for LPR are signals from video cameras that capture images of license plates. (Fig. 1, 2).

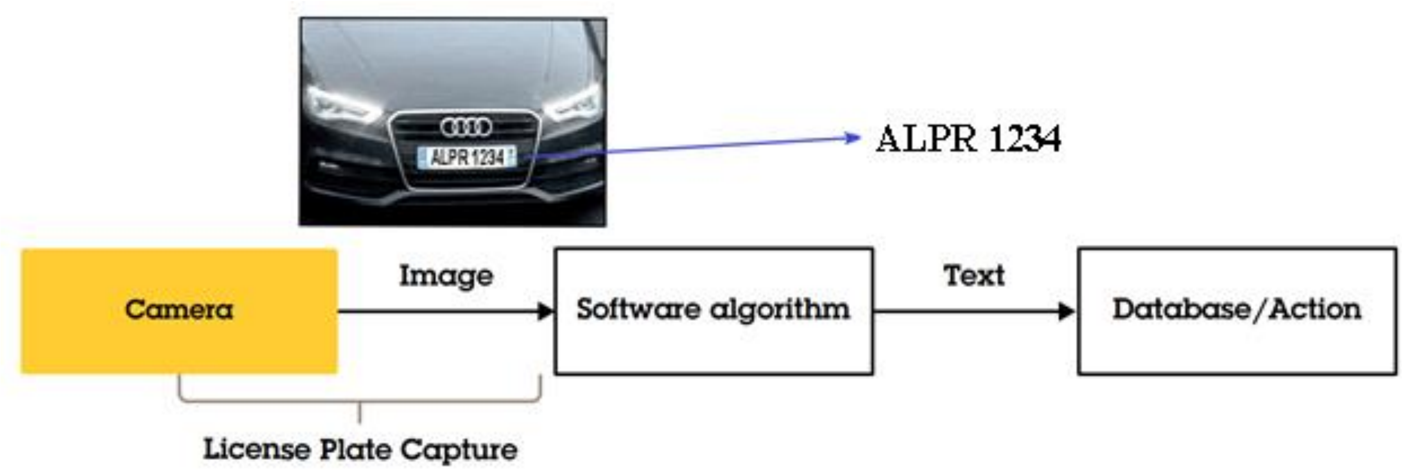

Figure 1: Parts of the LPR system

The images are processed by license plate analysis software that runs either directly on the camera or on a remote server. LPR software automatically finds and reads license plates in real-time. The detected license plates can be stored in a database for future use or can be used to trigger actions such as opening a gate.

An example of one of the working diagrams of the LPR process (Fig. 2).

Zone entry: The video camera captures the image of the front of the vehicle. Then the image is transferred to the program module. The software algorithm recognizes the image, writes the recognition result to the database, and returns it to the camera, and the camera sends a switching signal to the barrier switch.

Zone exit: The video camera captures the image of the front of the vehicle. Then the image is transferred to the program module. The software algorithm recognizes the image, outputs the recognition result, and compares it with the recognition result from the database when entering the zone. If the comparison is successful and the result is transmitted to the camera, the camera sends a
switching signal to the barrier switch.

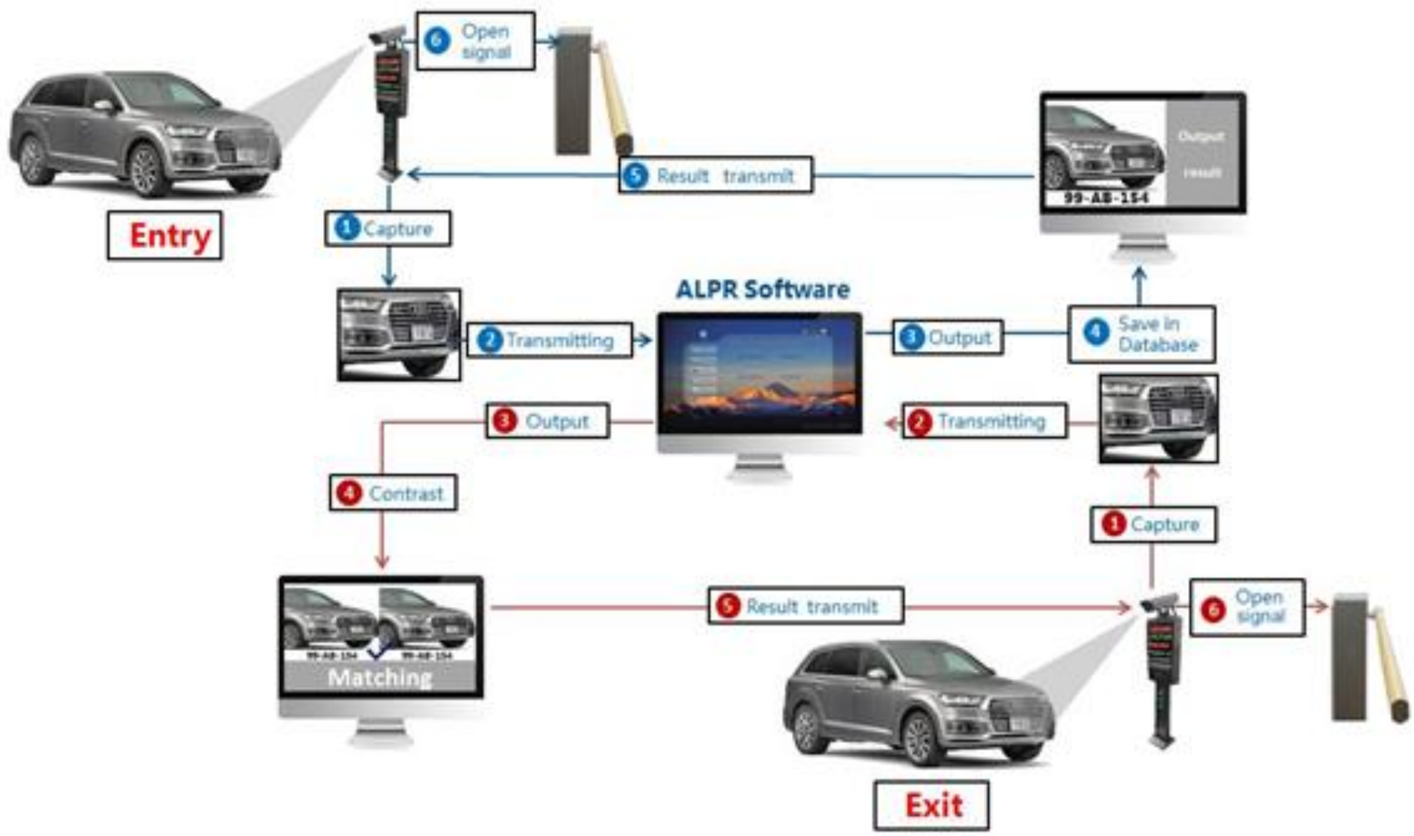

Figure 2: LPR workflow

This technology can be included in many different box solutions, all of them perform the same basic function, which is to provide a high-precision system for reading vehicle information without human intervention. It is used in a wide variety of applications such as access control, parking management, toll collection, user billing, delivery tracking, traffic management, police, and security services, customer service and directions, red light and lane compliance, assessment queue lengths, and many other services. (Fig. 3) shows a basic system diagram of fixed and mobile LPR technology.

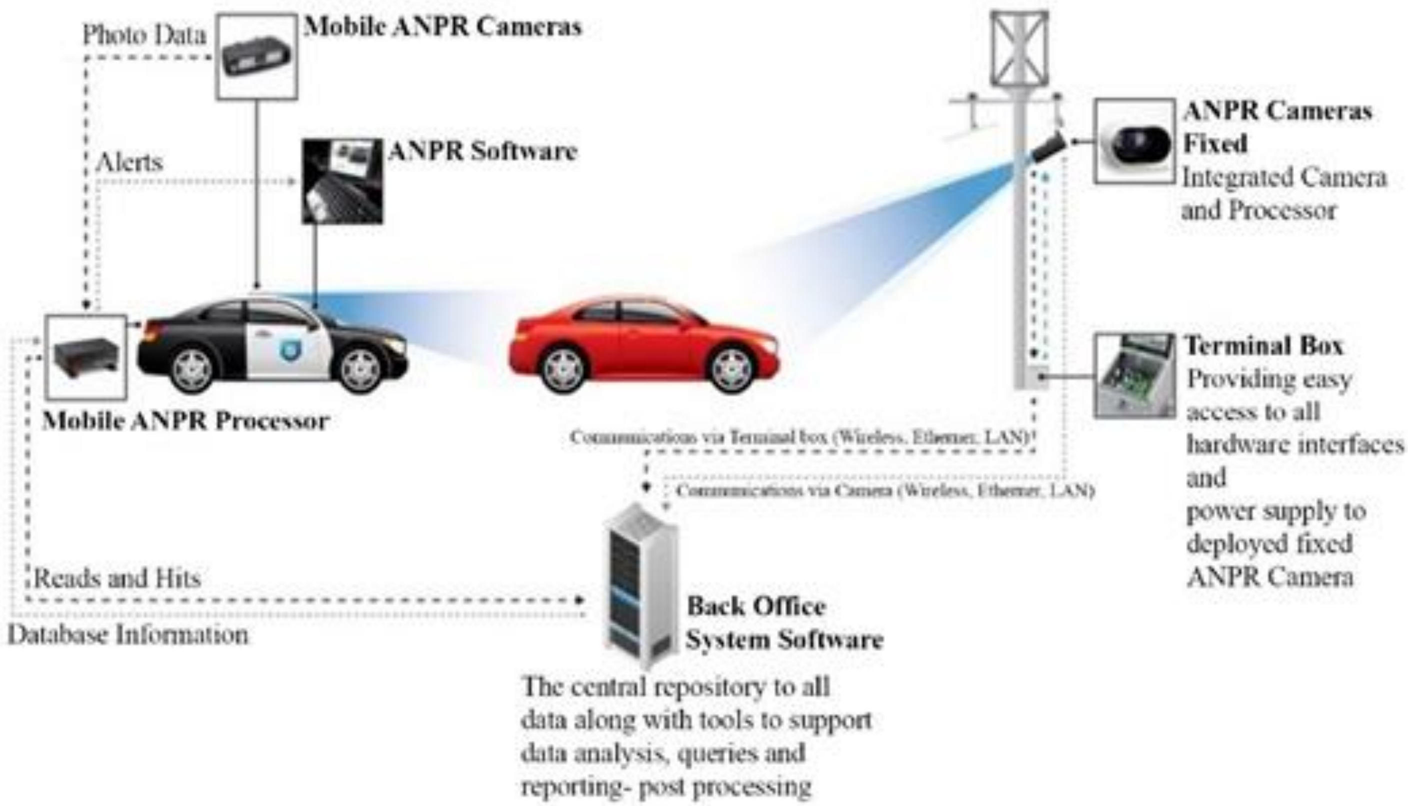

Figure 3: Typical ANPR System Diagram of a Fixed ANPR System (right) and a Mobile ANPR System (left)

Some of the pitfalls that LPR technology fights back include blurring the boundaries of license plate characters due to poor focus or vehicle movement, sharp-angle images due to a large camera angle, and low contrast. Numbers can be washed out due to glare from car headlights or reflections from sunlight, and many other factors can affect image clarity.

The speed and accuracy of vehicle license plate detection by the LPR system are highly dependent on the quality of the images captured by the camcorder. On the world market, there are camcorders from many different manufacturers with a wide variety of technical characteristics, the correct choice of which is the key moment for LPR to work.

License plate recognition involves capturing images of license plates from a highlighted area using a video camera. Either still images or dynamic videos are captured and further processed by a series of image-based recognition algorithms to achieve alphanumeric conversion of the captured images into text. Once a good quality image is obtained, the main dependency of any LPR system is the reliability of its algorithms. These algorithms require very careful consideration and require thousands of lines of code to get the desired results and cover all systemic complexities. The general processes involved in LPR systems are shown in (Fig. 4).

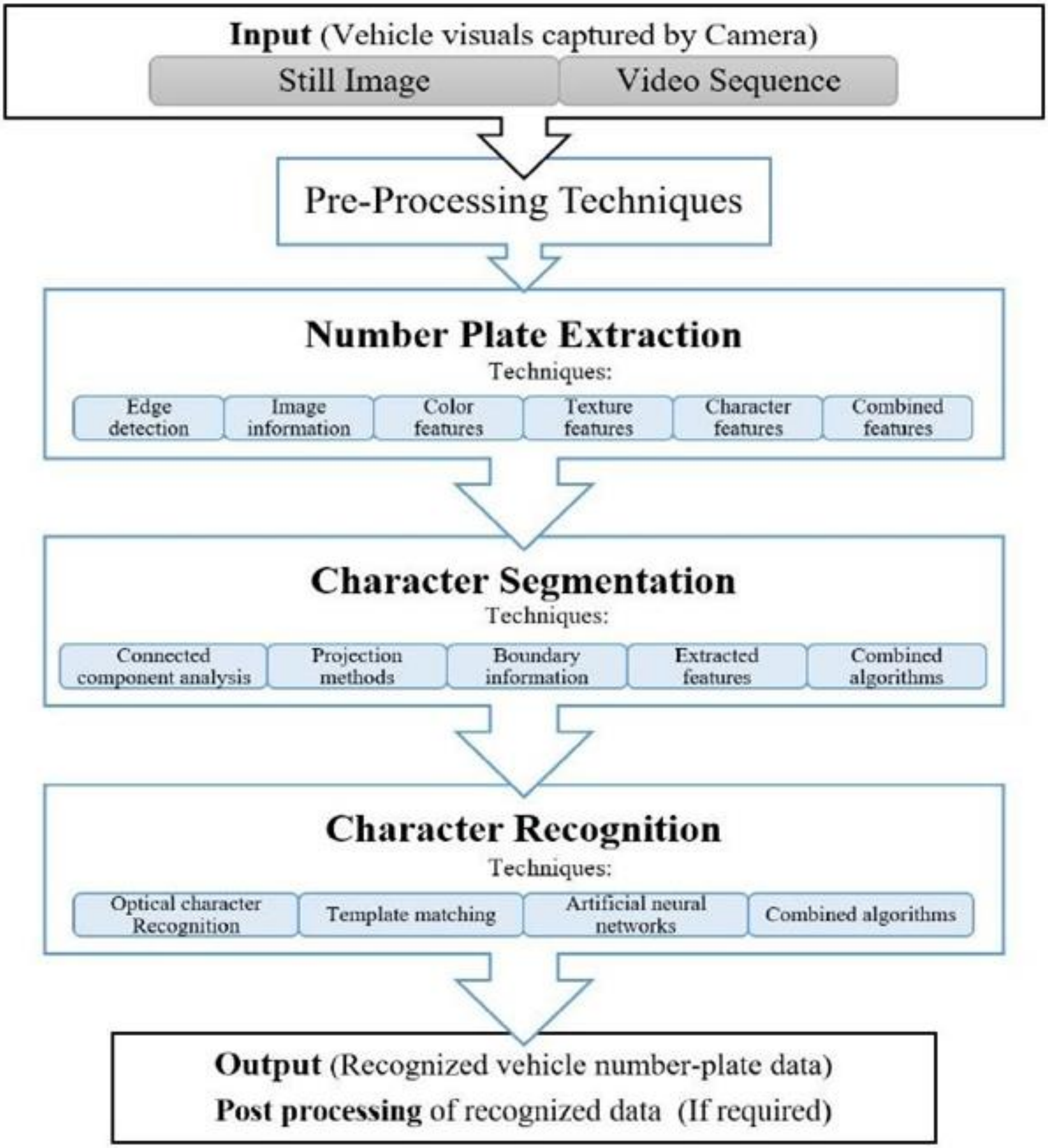

Figure 4: General processes of number plate recognition system

3. General Requirements and Recommendations

Any video camera is designed for video surveillance, nevertheless, it solves different tasks. It is important to understand under what conditions what information and to what quality it will be transmitted. In this case, the video camera must solve only one problem - the recognition of vehicle numbers. Therefore, when designing an LPR system, we recommend choosing video cameras with the following technical characteristics.

3.1Requirements for Video Cameras Technical Characteristics

- Sensitivity is not worse than 0.01 lux.
- Matrix size not less than 1/2 inch.
- Image resolution 1 MP (HD 720p). An increase in the camera resolution to more than 1 MP (HD 720p) does not lead to an improvement in the license plate recognition function since the photosensitivity of the camera matrix decreases with an increase in the image resolution.

- The lens should be chosen with the highest aperture (not less than F / 1.4) and, if possible, with a fixed focal length.

- It is desirable to have an automatic iris control (ARA) in the lens. Such a lens works on the principle of light and the pupil of the human eye: the more that enters it, the less it is transmitted inside. This helps to stabilize the image quality in case of strong changes in the illumination level in the observation area.

- The ability to set a fixed value of the electronic shutter with shutter speeds:

- 1/500 sec. - for speeds up to 40 km / h,
- 1/1000 sec. - for speeds up to 80 km / h,
- 1/2000 sec. - for speeds from 160 km / h and above.

Electronic shutter speeds for different camera angles are shown in Table 1. For details, see the Maximum Shutter Time1 section of this manual.

Camera Angle	30km/h (~19mph)	50km/h (~31mph)	80km/h (~50mph)	110km/h (~68mph)	130km/h (~81mph)
5º	19.3 ms	11.6 ms	7.2 ms	5.3 ms	4.5 ms
10º	9.7 ms	5.8 ms	3.6 ms	2.6 ms	2.2 ms
15º	6.5 ms	3.9 ms	2.4 ms	1.8 ms	1.5 ms
20º	4.9 ms	2.9 ms	1.8 ms	1.3 ms	1.1 ms
25º	4.0 ms	2.4 ms	1.5 ms	1.1 ms	0.9 ms
30º	3.4 ms	2.0 ms	1.3 ms	0.9 ms	0.8 ms

Table 1: Recommended max shutter time depending on the camera angle and car speed. 1 ms = 1/1000 s

- Color cameras must have a full Day/Night mode with a removable IR cut filter.

3.2. Pixel Density

In video surveillance, a parameter such as pixel density is used. Pixel density is usually expressed in pixels per meter. The pixel density in video surveillance should not be confused with the pixel density of monitors, which is defined in pixels per inch (PPI). The advantage of using a characteristic called "pixel density" is that this one parameter takes into account the size of the sensor, the number of pixels, the focal length of the lens, and the distance to the object of observation.

When designing an LPR system, it is important to calculate the required pixel density to achieve optimal image quality, sufficient for guaranteed license plate recognition. The license plate must be displayed in a frame with enough pixels to clearly distinguish letters and numbers. (Fig. 5). The best recognition is achieved within a certain range of license plate sizes in the image, in pixels, which is determined in a practical way.

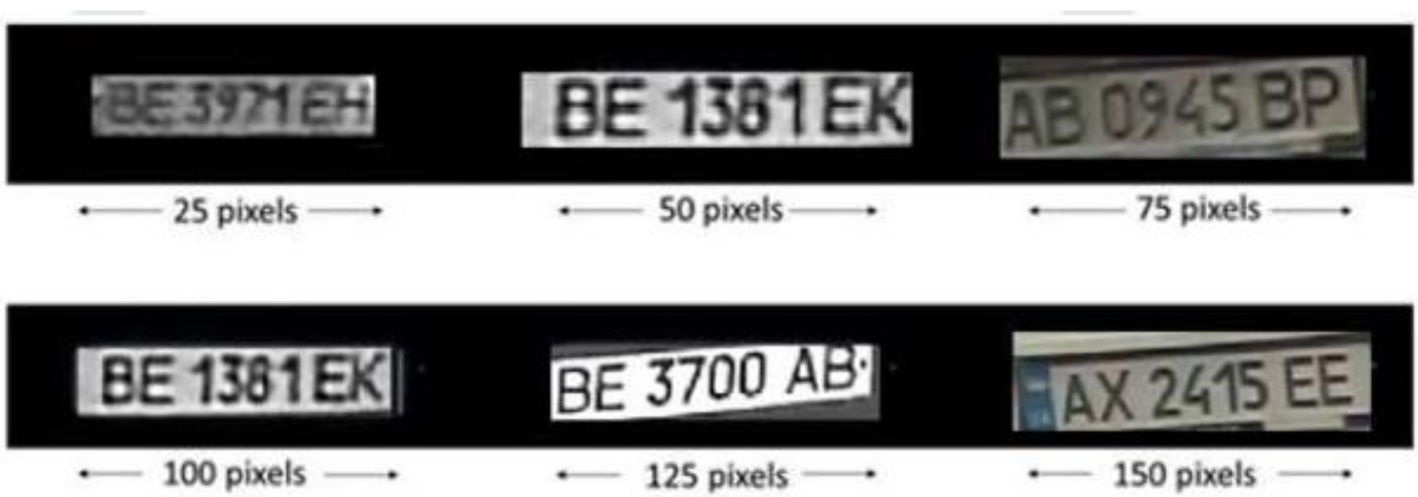

Figure 5: A European standard license plate should cover at least 75 pixels for the letters to be imaged with full contrast. Most LPR software requires 100-150 pixels over the width of the plate

For the LPR module to work effectively, the recognition area must be at least 200 pixels in height or width, and the aspect ratio must be at least 0.6 and no more than 2.

Examples of license plates for different countries are shown in (Fig. 6).

Figure 6: Number plates from various countries, (a) India (b) USA (California) (c) Australia (d) Pakistan (e) England (f) Italy (g) Japan (h) Iran

In most cases, a resolution of up to 1280x720 pixels is sufficient, which corresponds to the HD standard of 1MP, 720P. It doesn't make sense to use higher resolution cameras.

To determine the real pixel density, save a frame from a video camera and open it in Paint. Highlight the vehicle number with a block as shown in (Fig. 7). If the width of the number (px) does not match the one you selected, then adjust the camera lens.

Figure 7: Determination of pixel density in Paint

From the point of view of a video camera, the number of pixels on a license plate depends on the resolution of the image sensor and the field of view (Fig. 8, 9). A variable focal length lens gives you the freedom to choose your field of view - it can be zoomed in and out for a specific field of view.

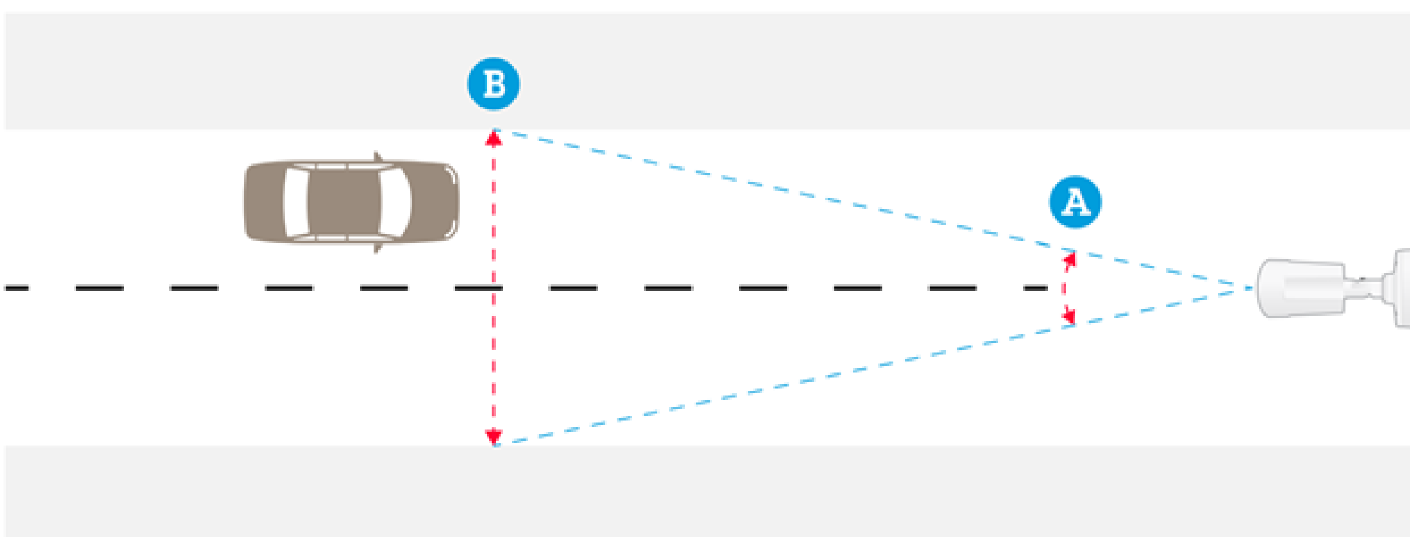

Figure 8: The scene width (B) which is visible in the image depends on the field of view (A)

Figure 9: The number of pixels across the width of the license plate depends on the camera resolution and the scene width. In this example a camera with a resolution of 1080x1920 pixels is

a) zoomed in on one lane (4 m wide)
b) zoomed out to cover almost two lanes (6.5 m wide). The license plate covers 250 pixels and 154 pixels respectively

The field of view depends on the sensor format and the focal length of the camera lens, as well as lens distortion, which can vary significantly between lenses. Below is Table 2 with the recommended horizontal field of view to cover one, two, and three lanes at different coverage distances.

Capture Distance:	5m (~ 16 ft)	10m (~ 33 ft)	30m (~ 98 ft)	16m (~ 164 ft)	80m (~ 262 ft)
1 lane < 4 m (~13ft)	$33^{0} - 44^{0}$	$17^{0} - 23^{0}$	$6^{0} - 8^{0}$	$3^{0} - 6^{0}$	$2^{0} - 3^{0}$
2 lanes < 8 m (~25 ft)	$62^{0} - 77^{0}$	$33^{0} - 44^{0}$	$11^{0} - 15^{0}$	$7^{0} - 9^{0}$	$4^{0} - 6^{0}$
3 lanes < 12 m (~39 ft)	$84^{0} - 100^{0}$	$48^{0} - 62^{0}$	$17^{0} - 23^{0}$	$10^{0} - 14^{0}$	$6^{0} - 9^{0}$

Table 2: Recommended horizontal field of view

Table 3 lists the recommended minimum sensor resolutions for one, two, and three lanes, respectively.

Note that these values are defined for European standard license plates. Smaller license plates may require a higher resolution.

Minimum Resolution	
1 lane, width < 4 m (~ 13 ft)	1MP (HD, 720p)
2 lanes width < 8 m (~ 25 ft)	2MP (Full HD, 1080p)
3 lanes width < 12 m (~ 39 ft)	5MP (5MP Lite,1920p)

Table 3: Minimum resolution

The disadvantage of using high-resolution camcorders is that LPR software takes a long time to analyze each image. This increases the risk of missing some numbers in heavy traffic.

3.3. IR Light

Artificial lighting is required to shoot license plates at night. Infrared (IR) light is commonly used because it is invisible to the eye and does not blind drivers. Most license plates are infrared reflective, and infrared light increases the visibility and contrast of the license plate in dark or cloudy weather. IR light can come from LEDs built into the camera or from IR sources outside the camera.

As the distance to the light source increases, its intensity decreases in a quadratic relationship. For a reflective object such as a license plate, this means that every doubling of the distance between the light source and the object will require a fourfold increase in IR power to keep the object the same visibility (Fig. 10). Acceptable quality for night recognition is shown in (Fig. 11).

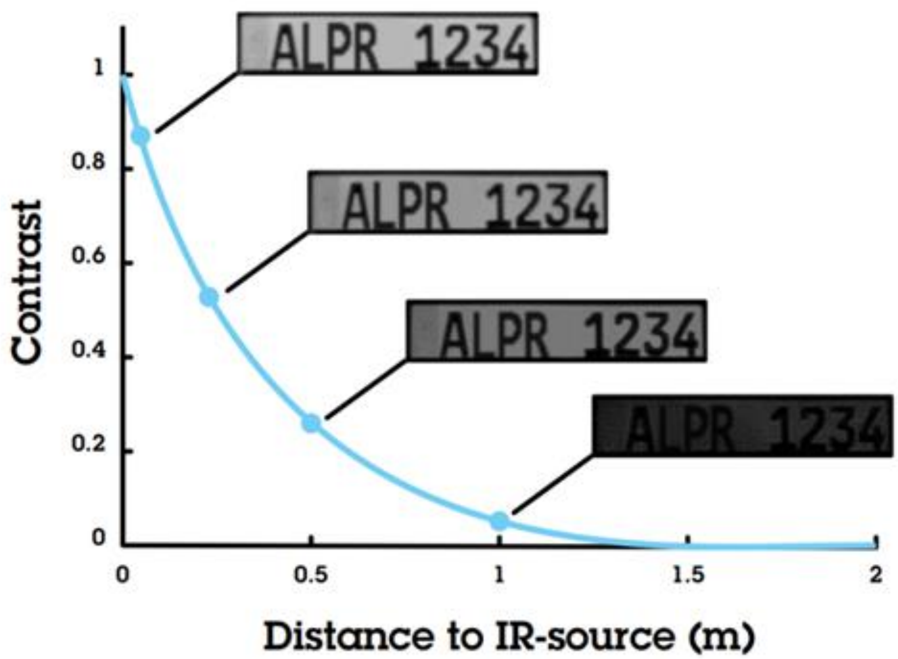

Figure 10: The brightness and contrast of a license plate in a camera image decreases quickly as the IR source is moved away from the camera (perpendicularly to the road)

Figure 11: Acceptable quality of night license plate recognition

3.4. External Sources of Infrared Radiation

If the IR range is insufficient for the built-in LEDs, or if the camera does not have built-in IR LEDs, infrared sources external to the camera can be used. The light cone of the IR source must match the camera's field of view at the appropriate zoom level. License plates are made of reflective material, which means they reflect light right back where it came from, no matter what angle the light hits the license plate. When using an external IR source, the reflected IR light will return to the source. For this reason, external IR sources must be placed close to the camera so that the reflected light can enter the camera (Fig. 12).

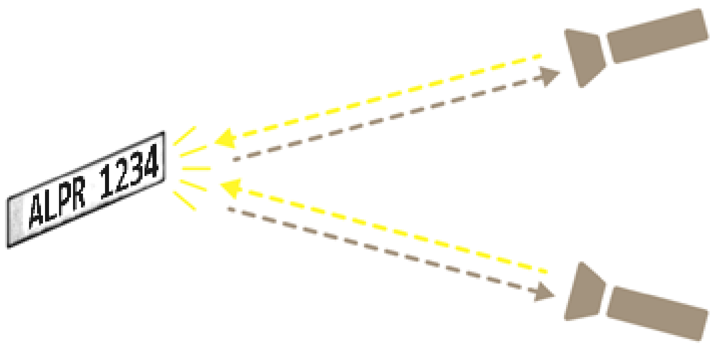

Figure 12: License plates are retroreflectors. They reflect light back where it came from

(Fig. 13) shows the relative contrast of the license plate at 10m, depending on the distance between the camera and an external source of infrared radiation.

Figure 13a: License plate contrasts at 10m from a passing vehicle. The IR source is located at 5m from the video camera

The IR source must be placed parallel to the camera so that the light falls on the part of the road that is in the camera's field of view.

Figure 13b: License plate contrasts 10m from a passing vehicle. The IR radiation source is located on the same optical axis as the video camera

4. Video Cameras Installation

Installing the camera is often a critical step as it can be difficult to remodel later. You should spend some time understanding the possible tradeoffs before proceeding with the installation of your camcorder.

4.1. Video Camera Position

The main parameters of the video camera position are the height of the installation above the track surface, the vertical and horizontal angle between the optical axis of the video camera and the average vehicle speed vector, the angle of the video camera image raster to the track surface (Fig. 14, 15).

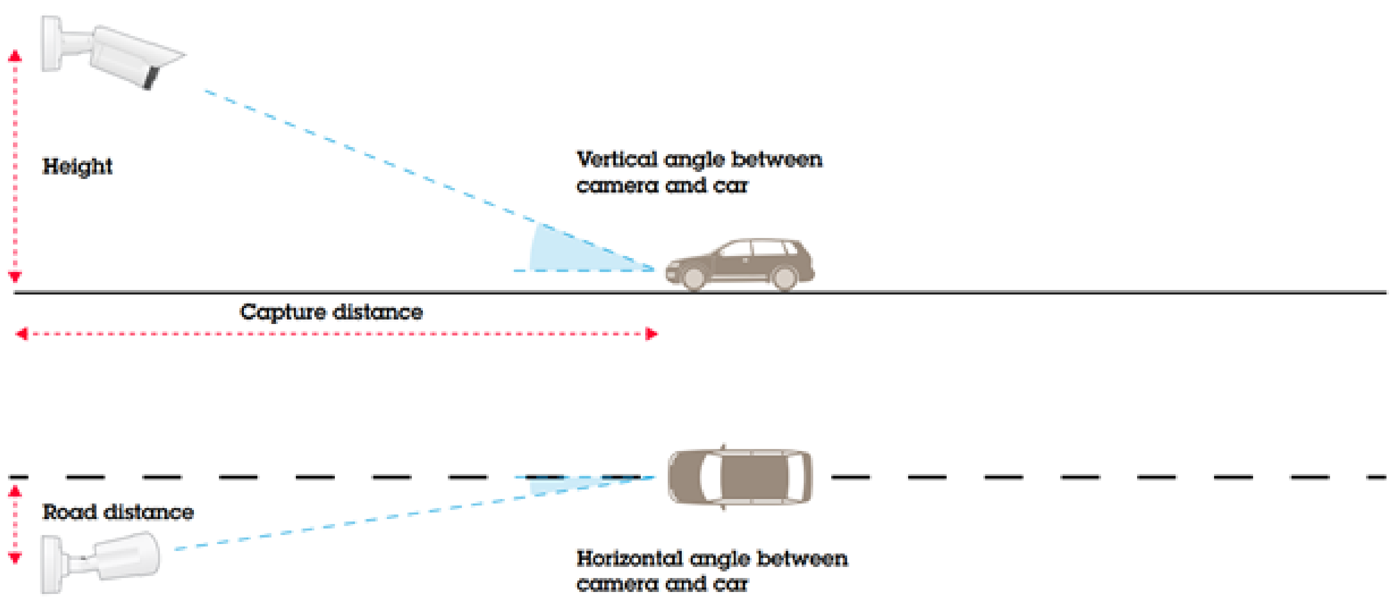

Figure 14: Positioning of the camera. The mounting height and distance from the center of the road determine the angle between the camera and the direction of motion of the car

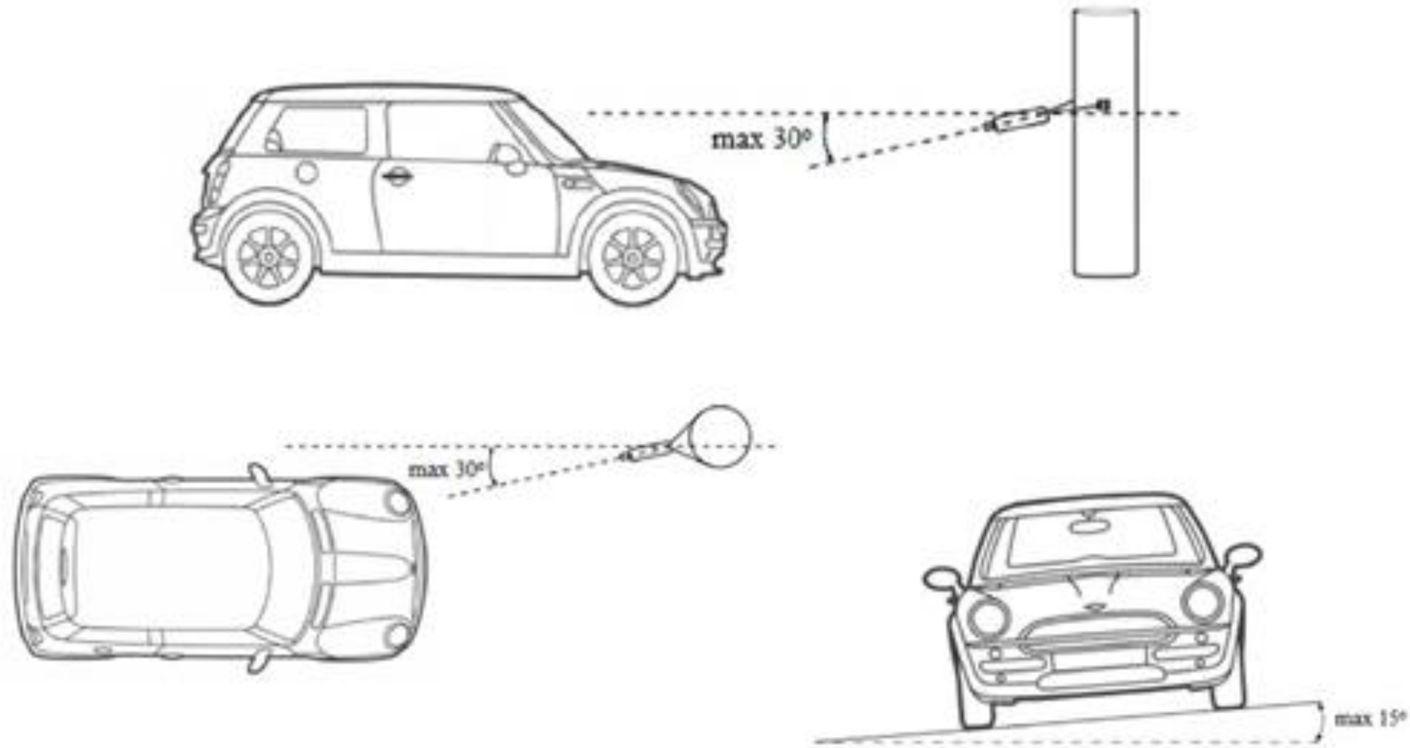

Figure 15: Requirements for tilting cameras

It is recommended to minimize the angle between the camera and the direction of movement of the vehicle, as shown in (Fig. 15). Ideally, you should place the camera directly over vehicles and not too high. However, it is recommended to position the camera above the headlights to avoid dazzling the camera with strong light. The recommended camera suspension height should be 1.5–2 meters above the road surface. The total angle between the camera and the direction of movement of the vehicle can be estimated from tables 4 and 5. We recommend keeping the total angle below 30 °.

4.2. Example of Correct Installation

Day

Night

Road distance = 0:

Capture Distance: Height:	5m (~ 16 ft)	10m (~ 33 ft)	30m (~ 98 ft)	50m (~ 164 ft)	80m (~ 262 ft)
1.5m (~ 5 ft)	17^0	8.5^0	2.9^0	1.7^0	1.1^0
3m (~ 10 ft)	31^0	17^0	5.7^0	3.4^0	2.1^0
5m (~ 16 ft)	45^0	27^0	9.5^0	5.7^0	3.6^0
7m (~ 23 ft)	54^0	35^0	13^0	8.0^0	5.0^0
10m (~ 33 ft)	63^0	45^0	18^0	11^0	7.1^0

Table 4: Camera angles at road distance 0. Red text indicates that the angle is too large for LPC

Road distance = 2 m (~ 7 ft):

Capture Distance: Height:	5m (~ 16 ft)	10m (~ 33 ft)	30m (~ 98 ft)	50m (~ 164 ft)	80m (~ 262 ft)
1.5m (~ 5 ft)	27^0	14^0	4.8^0	2.9^0	1.8^0
3m (~ 10 ft)	36^0	20^0	6.9^0	4.1^0	2.6^0
5m (~ 16 ft)	47^0	28^0	10^0	6.1^0	3.9^0
7m (~ 23 ft)	56^0	36^0	14^0	8.3^0	5.2^0
10m (~ 33 ft)	64^0	46^0	19^0	12^0	7.3^0

Table 5: Camera angles at road distance 2m (~ 7 ft). Red text indicates that the angle is too large for LPC

4.3. Our Recommendations for Video Camera Installation

- The camera should be installed on a stationary structure that should not swing or vibrate.
- If you are installing the camera on a roadside post, check how the post reacts to heavy vehicles passing by. With high vibration, license plate recognition is almost impossible.
- Avoid placing the camcorder in front of bright light sources such as streetlamps as they may interfere with the auto-exposure function and cause glare and reflections in the optics.
- It is desirable that there are no light sources in the frame that slowly change their position.
- Mandatory absence in the observation cone of extraneous static or dynamic interference, such as trees, pedestrian crossings, etc.
- If you don't know how many pixels the number occupies, take a screenshot, and use a graphics editor to check it (Fig. 8).

4.4. Camera Alignment

The camera should be aimed at the road so that the corresponding lanes are in the center of the image. It should be increased to cover the desired number of lanes, but no more. The angle of rotation of the camera should be adjusted so that the license plate is parallel to the edges of the image (Fig. 16). The maximum swing angle deviation is shown in (Fig. 17).

Figure 16: The camera should be aligned so that the license plate is parallel to the edge of the image

Figure 17: Maximum swing angle deviation

The distance between the camera and the part of the road that it captures is called the capture distance, as shown in (Fig. 14). Pick-up distance should be chosen with care as it affects the ability to detect license plates in different ways. In the remainder of this chapter, we will discuss the various parameters that affect the choice of the capture distance.

4.5. Depth of Field

The camera must be well focused for the license plates to be clear and legible. However, the image must be clear not only at one specific distance but also in the range of distances around the focal plane, as shown in (Fig. 18).

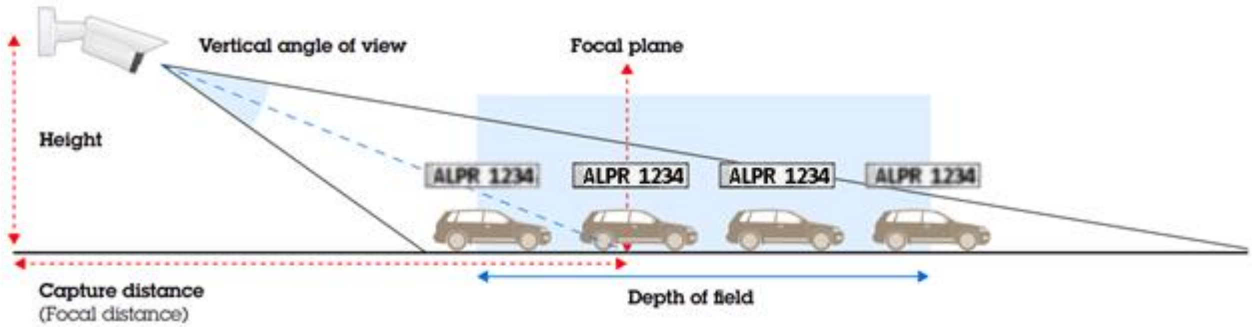

Figure 18: The depth of field determines the range around the focal plane where the image is still acceptably sharp

The size of this range is called the depth of field (DOF). The depth of field is usually greater for a longer capture distance. The depth of field can be increased by decreasing the aperture size. This is only necessary for short capture distances, less than 10 m when the depth of field is shallow. Reducing the aperture should be done with caution as it limits the camera's performance in low light.

4.6. Detectable Range

The detectable range is the range of distances along the road at which the license plate is visible and readable in the image (Fig. 19). Ideally, the detectable range is the full field of view of the camera, but this is not always the case. The detectable range can be limited by the depth of field of the camera, and vehicles far away are sometimes too small to be clearly recognized.

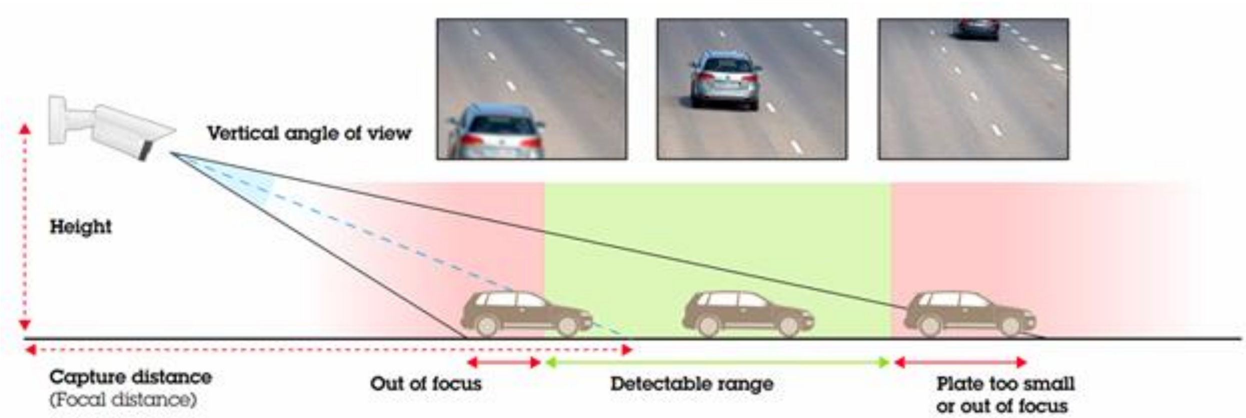

Figure 19: The detectable range can be limited by the depth of field and resolution

Weather conditions such as snow, rain, and fog can severely limit visibility over long capture ranges and therefore limit the detection range.

In the daytime and in good weather conditions, the detection range increases with an increase in the capture range. For vehicles moving at high speed, a long capture distance must be used to allow enough time to read the license plate before the vehicle is out of sight.

4.7. Recommended Capture Distance

Table 6 shows the recommended minimum catching distance depending on the speed of the vehicles. The numbers are based on an estimated detection time of 0.2s, which means the LPR software can analyze five frames per second. Please note that the number of analyzed frames per second may vary depending on LPR software and different processors and depending on the image resolution. Table 6 is just a guide.

Car Speed	Recommended Minimum Capture Distance
30km/h (~ 19mph)	7m (~ 23 ft)
50km/h (~ 31mph)	11m (~ 36 ft)
80km/h (~ 50mph)	24m (~ 79 ft)
100km/h (~ 62mph)	27m (~ 89 ft)
130km/h (~ 81mph)	30m (~ 98 ft)

Table 6: Minimum capture distance for different car speeds. Might require reducing the iris aperture for increased depth of field

At night, the maximum possible capture distance is often limited by the infrared range. IR reach can be improved by using more powerful external IR sources.

5. Video Camera Settings

Attention! Before starting the installation, read in detail the accompanying documentation that comes with the specific model of the selected manufacturer. It is important to find out the following technical details:

- Any IP camera requires a power cable, a network cable, and a standard port connection to a router or switch, connectors, a bracket, and a power supply. You must select the correct accessories for your model.
- If the camera has pan/tilt mechanisms, additional mechanical settings must be made after installation and initial setup, otherwise, the remote pan/tilt functions will not work.

Camera settings are important. Dedicated license plate cameras come with suitable default settings and require minimal setup. For other cameras, the following settings may need to be changed.

5.1. Maximum Shutter Time

Vehicles moving across the image will cause motion blur as shown in (Fig. 20) if the camera shutter time is too long. The maximum shutter time depends on the camera setting as well as the speed of the vehicles.

Figure 20: A car moving at high speed is imaged with an exposure time of 1/30 s

A car approaching the camera will not move across the image but will simply get bigger as it gets closer. This effect can often be neglected. But as soon as there is an angle between the camera and the direction of travel, the car will move laterally in the image at a speed that depends on the angle. Lateral speed will cause motion blur with a normal shutter time of about 1/30 s, so the maximum shutter time should be limited. Table 7 shows the recommended maximum shutter time depending on the angle between the camera and the direction of travel of the vehicle, as well as the speed of the vehicles. The camera viewing angle can be estimated from Tables 3 and 4.

Camera Angle:	30km/h(~19mph)	50km/h(~31mph)	80km/h(~50mph)	110km/h(~68mph)	130km/h(~81mph)
5^0	19.3 ms	11.6 ms	7.2 ms	5.3 ms	4.5 ms
10^0	9.7 ms	5.8 ms	3.6 ms	2.6 ms	2.2 ms
15^0	6.5 ms	3.9 ms	2.4 ms	1.8 ms	1.5 ms
20^0	4.9 ms	2.9 ms	1.8 ms	1.3 ms	1.1 ms
25^0	4.0 ms	2.4 ms	1.5 ms	1.1 ms	0.9 ms
30^0	3.4 ms	2.0 ms	1.3 ms	0.9 ms	0.8 ms

Table 7: Recommended max shutter time depending on the camera angle and car speed. 1 ms = 1/1000 s

Note that the camera will collect more light with a longer shutter time, which increases the IR range.
For example, by setting the camera at a 5 ° angle instead of a 20 ° angle, the shutter time can be increased by about four times, which will double the IR range.

5.2. Maximum Gain

Since the license plate is made of reflective material, it will glow brightly when exposed to intense infrared light. The environment will be much darker as other objects reflect much less light. As a result, the license plate may become overexposed and unreadable. The easiest way to avoid license plate overexposure is to limit the maximum gain of the camera, as shown in (Fig. 21).

Figure 21: The max gain setting will determine how the license plate is exposed at night

How to set the maximum gain depends on the available IR intensity, distance to vehicles, and camera sensitivity.

5.3. WDR

Wide dynamic range (WDR) includes various methods to increase the dynamic range of an image. WDR is very useful for revealing details that might otherwise be hidden in shadows, or for preventing strong light from "dazzling" the camera.

WDR can cause motion artifacts in images of moving vehicles, depending on how WDR is implemented in a particular camera. Unless otherwise specified in the camera specifications, we recommend that you always turn off WDR to capture a license plate.

If on a freeze-frame the license plate looks clearly without blurry borders, then the recognition module will be guaranteed to be able to identify it.

5.4. Tone Mapping or Local Contrast

The tone mapping adjustment is used to emphasize detail and contrast in dark parts of an image. On cameras with an ARTPEC-6 chip or earlier, this setting can be changed using the local contrast setting. ARTPEC-7 cameras have improved functionality and have a separate tone mapping option. Tone mapping or local contrast can help make license plate letters and numbers stand out, but if set too high, it can also increase glare and reflections from headlights and make the image gray and noisy (Fig. 22).

Figure 22: Local contrast on a camera with ARTPEC-6 is a tradeoff between good contrast in the license plate, and too much noise and glare in the image

We recommend keeping the local contrast below 50% on cameras with the ARTPEC-6 chip and disabling the color mode. A black and white image is more contrasting than a color one and is better perceived by the recognition module.

6. Image Filters

Video camera image filters are an optical lens that gives the picture an additional effect: removes unnecessary glare, softens the light, adds the necessary colors. A good light filter can improve a frame in terms of light transmission, a poorly selected, questionable quality can destroy a good video. Filters are optical, polarizing, and infrared.

6.1. Optical Filters

Adding optical filters to the light path in the camera can improve the image in some specific situations. However, they often block a significant amount of light, which degrades low-light performance and introduces more noise into the image. Therefore, we do not recommend their use for recognition of vehicle license plates.

6.2. Polarizing Filters

A properly set polarizing filter can reduce reflections from flat surfaces such as a car windshield or road surface. In some cases, it can be useful for general traffic monitoring, for example, to improve the visibility of the vehicle interior. However, it blocks 50% of all light from entering the camera, and this can significantly reduce the quality of license plate visibility. For this reason, we do not recommend using a polarizing filter.

6.3. Infrared (IR) Filters

An IR cut filter blocks visible light and only allows thermal infrared light to pass through. Since the license plate reflects much more infrared light than the environment, the image will be darker and only the license plate will shine brightly, and this can help recognition algorithms make the license plate stand out. It can also be a way to improve the recognition quality at night.

The filter can block light from car headlights to prevent glare and reflections in the lenses. In this way, the light from the LED headlights is filtered very efficiently. On the other hand, halogen headlights emit a lot of light in the infrared wavelength range, and this light is not filtered out effectively. The difference is easy to see in (Fig. 23), which compares images with LED and halogen headlights.


Fig. 23a


Fig. 23b

Figure 23: Two images taken with a camera equipped with an IR-pass filter. The two images are taken directly after each other with identical settings and alignment

a) The light from LED headlights is blocked by the IR-pass filter, which efficiently reduces lens glare and stray light
b) The light from halogen headlights goes through the IR-pass filter and gives rise to lens glare

6.4. Recommendations

We recommend a compromise solution, the essence of which is that it is necessary to adjust the size and position of the field of view in such a way that only the zone of maximum probability of the location of license plates in space falls into it (Fig. 24). This technique can reduce the amount of light from the headlights of the car entering the camcorder.

This can be realized by changing within a small range of the angle of inclination of the video camera, which depends on the height of its installation, focal length, and distance to the object of observation.

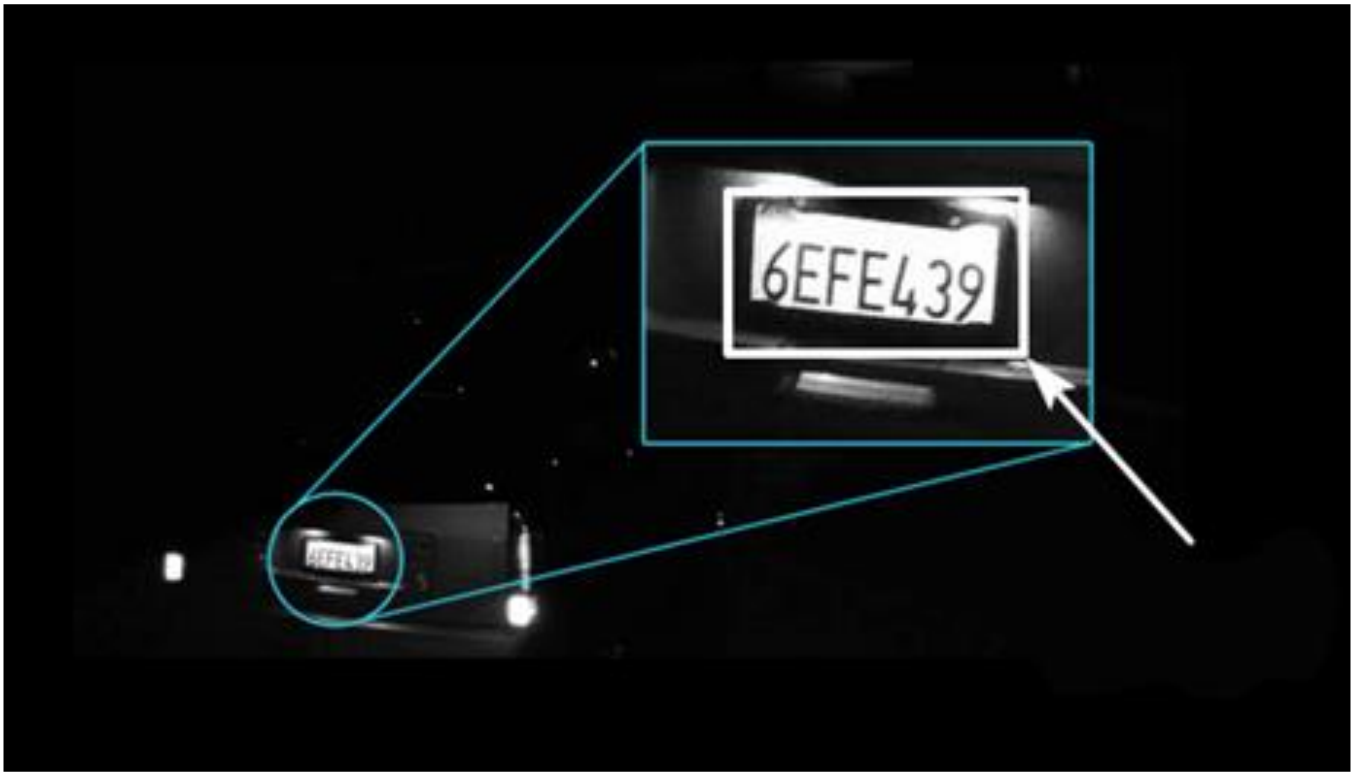

Figure 24: Minimizing the capture area

In general, an IR cut filter in night mode can improve detection speed and accuracy. We recommend using it. However, it must be turned off during the daytime.