IP Camera Setup for ALPR

Best Practices for Optimal Recognition

Version 1.0

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1. Table of Contents

1 Camera Location for License Plate Recognition

This is the single most important factor in achieving high recognition accuracy. The installer should optimize the license plate character height (in pixels) and the perspective and angle of the license plate within the camera's image.

The location of the camera has a crucial role in the overall performance of the ALPR system and must be treated with the utmost care.

1.1 Minimizing false triggering during recognition

It is important to install the camera in a way that no high contrast objects (e.g. billboards, wire fences, trees, windows in buildings, parked vehicles etc.) are visible in the image frame.

These objects may cause false triggering during recognition. Additionally, the camera should not be pointed directly at light sources such as the sun, bright streetlights, or reflective surfaces such as road-signs.
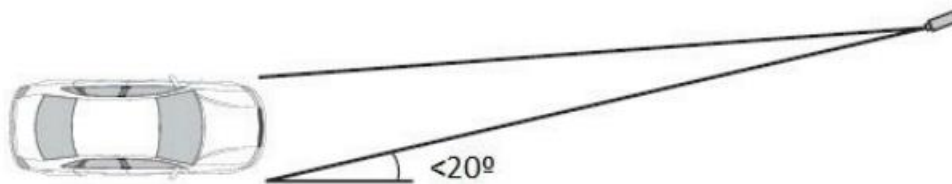
1.2 Camera Installation

In this section, we will describe the optimal settings for high accuracy ALPR. You should consider the camera's distance from the target plate, camera height, image field of view and depth of field which affects focus.

The following recommendations will help you fully understand the effects of camera placement.

1.2.1 Gate or Barrier Installation

In this scenario, the vehicle approaches a barrier and comes to a complete stop before entering or leaving a controlled area. When installing the ALPR camera, we recommend the following:

- The Distance between the camera & the reading point should be between 2 & 6 meters.
- The Height of the camera should be above or below the level of the barrier so that it does not block the camera's vision. If it is above the barrier, it should ideally be between 1.5 and 2 meters high.

- The Camera's vertical angle to the plate should be less than 30 degrees. (See below)
- The Camera's horizontal angle to the plate should be less than 20 degrees. (See below)
- When the camera is setup to read plates in a single lane:
  -The full width of the vehicle should fill the field of view, - no more.
- When the camera is setup to read plates across multiple lanes:
  -One camera should cover a maximum of 2 lanes.
  -The captured image should only be filled with the full width of the two vehicles.
- The Aperture of the lens should normally be between f/5.6 and f/8 to produce an adequate depth of field. The smaller the lens aperture, the more "in-focus" objects will be at varying distances.
- The Camera should have an IR illuminator. This should preferably be internal as the LEDs will be closer to the lens meaning that more light is reflected from the plate at close distances. (This LED to lens angle should be less than 5°).

Maximum recommended angle on the horizontal axis
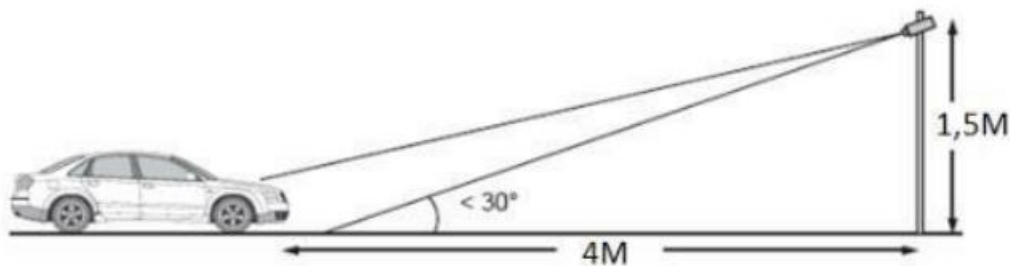
Maximum recommended angle on the horizontal axis

1.2.2 Roadside Installation

In this scenario, the vehicle is in motion and the ALPR camera can be sited on an overhead gantry looking down on the traffic or mounted on a pole to the side of the road.

Gantry-Mounted for front or rear capture (Front is normally recommended)

When installing the ALPR camera on an overhead gantry or bridge, we recommend the following settings:
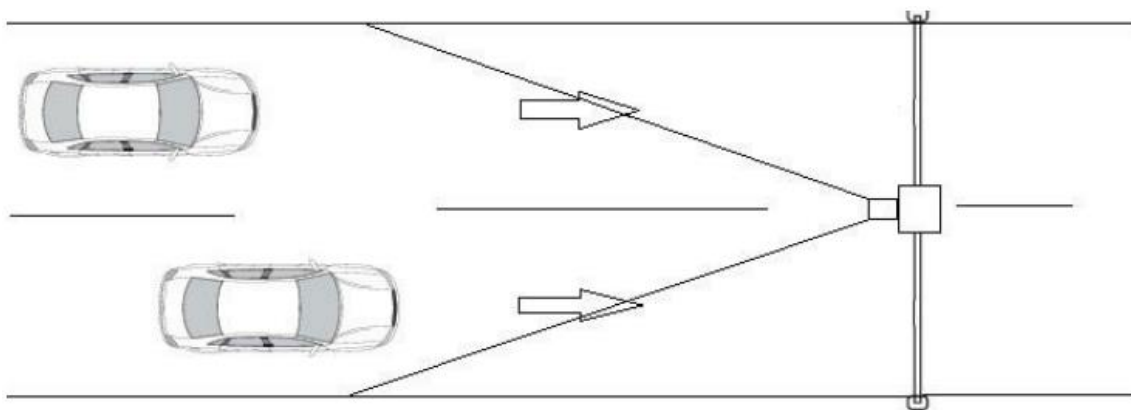
- The Distance from the camera and the reading point should be between 15 and 30 meters.
- The Camera height should be between 3.5 and 6 meters.
      NOTE: The height limit of the vehicles should be considered.
- The Camera's vertical angle to the plate should be within 30 degrees.
- When the camera is set up to read plates in a single lane:
      -The camera should be centered in the lane. (See below)
      -The full width of the vehicle should fill the field of view, - no more.
   -When the camera is setup to read plates across multiple lanes: -
      - One camera should cover a maximum of 2 lanes.   (See below)
      -The camera should be centered across the two lanes.
      -The captured image should only be filled with the full width of the two vehicles.
- The Aperture of the lens should be set to between f/5.6 and f/8 to produce an adequate depth of field. The smaller the lens aperture, the more "in-focus" objects will be at varying distances.
- The Camera should be fitted with a powerful IR illuminator that can evenly diffuse the light across the whole of the field of view.
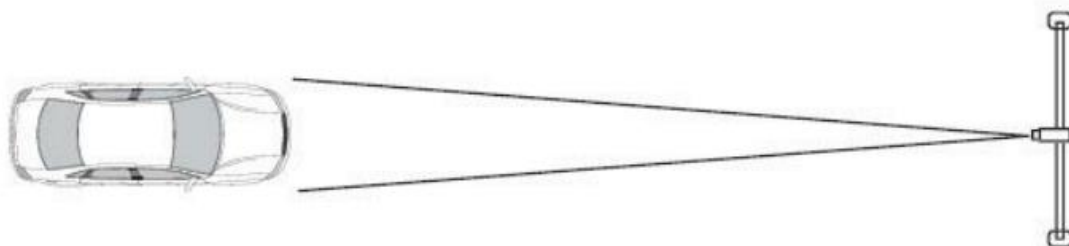
Camera with a front view of a single lane from a gantry
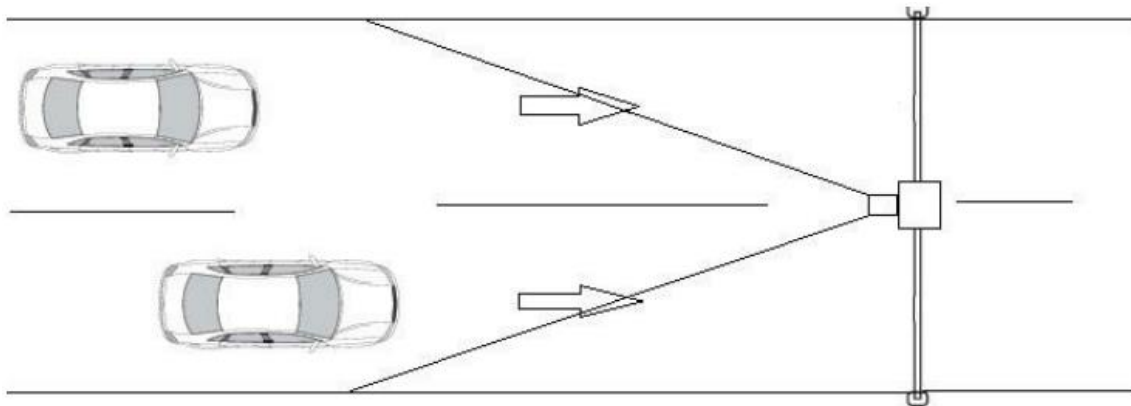
Camera with a front view of a two adjacent lanes from a gantry

Maximum angle of the vertical axis

Pole-Mounted at the side of the road

When installing the ALPR camera on the side of the road, we recommend the following settings:

● The Pole should be as close to the road as possible to minimize angles and to avoid capturing unnecessary objects. Use an out-rigger if necessary to reduce the angles.

- The Distance from the camera and the reading point should be between 15 and 30 meters.
- The Height of the camera should be between 3.5 and 6 meters to capture the front part of the vehicle only.
- The Camera's vertical angle to the plate should be within 30 degrees.
- The Camera's horizontal angle to the plate should be within 20 degrees.
- When the camera is setup to capture plates in a single lane:
    - -The full width of the vehicle should fill the field on view, - no more. (See below)
- When the camera is setup to read plates across multiple lanes:
    - -One camera should cover a maximum of 2 lanes.   (See below)
    - -The captured image should only be filled with the full width of the two vehicles.
- The Aperture of the lens should normally be between f/5.6 and f/8 to produce an adequate
- depth of field. The smaller the lens aperture, the more "in-focus" objects will be at varying distances.
- The Camera should be fitted with a powerful IR illuminator that can evenly diffuse the light
- across the whole of the field of view.
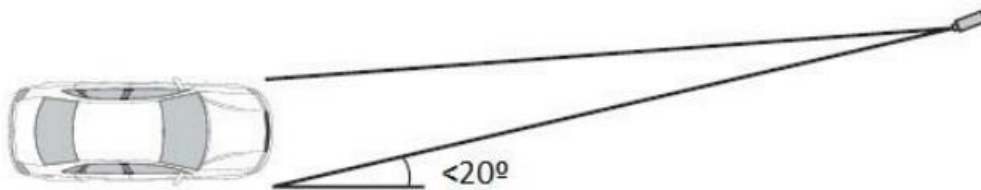
Camera's recommended horizontal setup angle
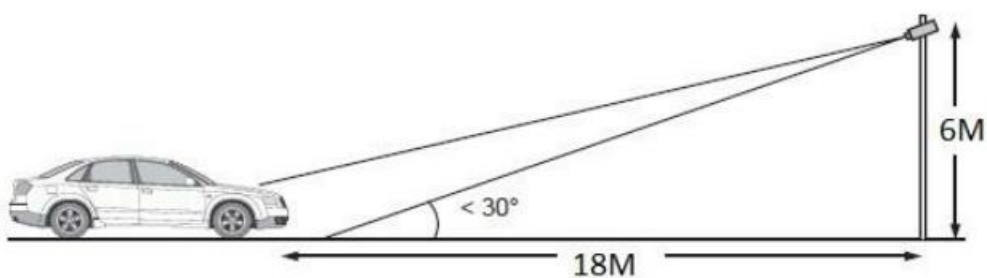
1.3 Infrared illumination

In all the above scenarios above the Infrared (or IR) illuminators should be used for night time operation. These are designed to provide additional illumination that the camera can see but

humans normally cannot. In low light conditions, an IR illuminator is used as a spotlight to facilitate 24-hour recognition. It can penetrate darkness and to a lesser extent fog, rain and snow and it eliminates the inconsistency of ambient light.

Infrared illuminators add light across the camera's field of view to produce the desired image quality, lighting up the area and reflecting the plate.

For ALPR, it is recommended that the camera always has an infrared illuminator. This can be built into the camera or added as an external unit providing that it is placed very close to the camera lens. (The angle made between the light leaving the IR light source and that of the reflected light returning to the camera lens should be 5° or less.)

1.4 Camera Orientation

The image orientation is a key factor to achieve the maximum OCR efficiency. It is recommended that you stay below the following thresholds:

Examples of different camera orientations

1.5 Guidelines for Different Situations

On a motorway or highway bridge above the traffic, then a height to distance ratio of about 1:3 is fine. So, at a height of 6m, aim to capture plates at about 18-24m down the road. For single lane applications, the camera is fine at the side of the road. Try to minimize the angles as always. If vehicles turn as they approach the camera – then try to minimize the angles.

At a barrier, use a low mounted camera looking below the barrier arm – or a higher mounted camera looking over the barrier arm – but beware that a rising arm can partials obscure the plate and sometimes cause an extra partial plate to be read.

At site entrances, sometimes cameras can be ceiling mounted to get an unobscured view of the approaching plate – but bear in mind the 1:3 ratio. Vehicles approaching a site entrance can tailgate and if not separated then the tailgating plate will not be read. Separate cars using speed-bumps.

Very wide lanes can cause problems. Insist on some traffic management to guide vehicles into the camera's field of view.

2   Camera configuration

2.1 Shutter Speed

The shutter speed should ideally be at 1/1000th sec (1 millisecond), – but if the traffic is moving slowly then this can be decreased to a slightly slower shutter speed while keeping the images sharp.

This means that the plates will appear brighter without having to use gain (which introduces noise and can cause mis-reads). On cameras with manual irises, then these can be closed slightly. e.g., set to f8 reducing the size of the aperture and thereby increasing the depth of field – keeping the vehicle in focus for longer as it travels through the field of view.

- **Barrier or Gate** ⟶   Minimum exposure time **1/250th sec** (4 milliseconds)
- **Road or Street** ⟶   Minimum exposure time **1/500th sec** (2 milliseconds)
- **Fast Urban** ⟶   Minimum exposure time **1/1000th sec** (1 millisecond)
- **Motorways** ⟶   Minimum exposure time **1/1000th sec** (1 millisecond)

2.2 Frame Rate

The number of frames that the camera sends to the computer per second is called the frame rate. The camera defaults are often quite high and not always needed. This can again save processing power for systems with many cameras connected.

- **Barrier or Gate** ⟶   Frame rate > **5fps**
- **Road or Street** ⟶   Frame rate > **15fps**
- **Fast Urban** ⟶   Frame rate ≥ **20fps**
- **Motorways** ⟶   Frame rate ≥ **25fps**

2.3 Camera Resolution, Lens and Field of View

Set the resolution of the Camera's Primary IP Stream to a maximum setting of 1920 x 1080 for 6m wide (dual width) lanes and 1280 x 960 (or similar) for 3m single lane reading.

Setting the resolution higher than this is not necessary and the larger images produced use more CPU power to process and normally have less quality.

Select the correct lens for the distance you want to read at by using the supplied Lens Calculator and not use digital zooming

As a rule, if you can clearly read the plate from the video image, then the ANPR software will be able to read it also. Make sure that the plate is readable at the target read range and it should have a character height of about 20-35 pixels for larger plate formats (e.g. EU 50cm plates) and about 25- 35+ pixels for USA–style plates which are physically smaller and have a narrow character stroke width in many states.

Certain Middle East and Arabic plates are smaller still and will need an even greater character pixel height of say 30-40 pixels. For example, in Abu Dhabi the small characters next to or above the main characters are only 3cm high and may require a much higher camera resolution.

The camera should be setup so that the combination of the **distance**, the **lens's focal length** and the **camera's resolution** provide an image that can be accurately analysed by the OCR.

3 Image quality

It is extremely important to select the correct camera and configure it correctly to maximize the quality of the image sent to the OCR program. A bad image will result in lower recognition.

The image quality not only depends on the resolution of the image and correct settings but also the video transmission rate, stream protocol and image format provided by the decoder and/or video filter technology within the camera. This part of the camera setup is often neglected.

You want crisp, bright images with a good contrast.
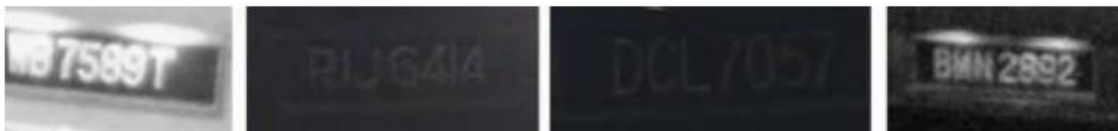
Bad quality images from Malaysian vehicles
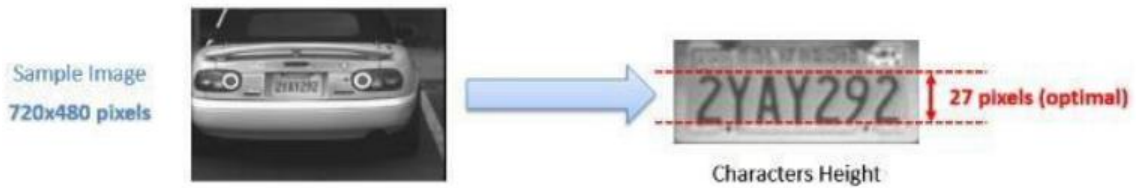

Good quality images from Malaysian vehicles

3.1 Characters Pixel Height

The most accurate way of measuring the size of the characters on a plate is to use the height of each character. The optimal range is from 25 to 35 pixels high.

Sample Image
720x480 pixels

27 pixels (optimal)

Characters Height
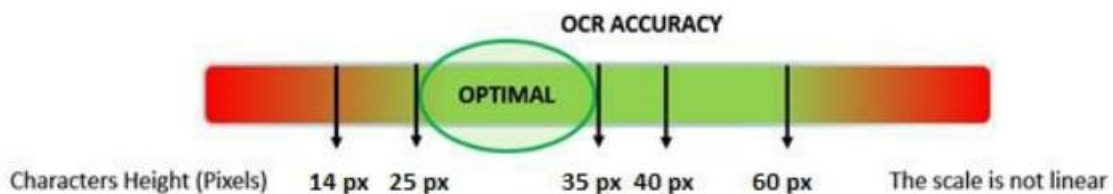
By using the VaxALPR Setup program, the OCR can be configured to read characters as low as 14 pixels high – or as high as 70+ pixels high, but to maximize reading accuracy and not waste processor time looking for very large plates you should keep this to about 20-30 pixels high. The main manuals shows how to do this.

Accuracy will decrease significantly if these guidelines are not adhered to.

3.2 Other Factors affecting Recognition

- Bad weather can affect accuracy. Plates covered with snow or road salt will cause severe problems.
- Dirty, illegal or plates that have been tampered with can cause misreads.
- Plate carriers that touch the edge or characters can cause misreads.
- Plate carriers with Perspex can cause light to be reflected or refracted and characters can be misread.
- Front plates are normally cleaner than rear ones as dirt vortexes are created behind a vehicle.
- All this is common sense, and a bit of practical experience will make all this obvious.

4 Summary of the most important factors affecting accuracy

Image resolution

Always use the minimum resolution that does the job properly, the more the more processing time the analytic requires, in some cases it will affect the detection rate. Do not use more resolution than you need.

Camera intrinsic parameters

Carefully check the shutter speed, WDR status, gain value... those parameters affect the image quality specially in high-speed motion or low lighting environments.

Camera horizontal angle (yaw)

Keep the horizontal angle as low as possible. The countries with lower text font width / height ratio are more sensitive to this. If the angle is high the OCR will lose accuracy

USA plate WH ratio = 0.41   Singapore plate WH ratio = 0.66

Camera vertical angle (pitch)

Do not exceed the 30 degrees and never mount the camera underneath the license plate as rain will then collect on the lens. High angles affect the OCR accuracy

Wide Dynamic Range

This can have a detrimental effect on the image especially at night where frames are combined to produce a more evenly lit image which can cause artifacts as follows:

4.1 Examples of good setups

CORRECT: Access control

CORRECT: Access control

CORRECT: 1x lane low speed

CORRECT: 1x lane low speed

CORRECT: 1x lane low speed

CORRECT: 2x lane low speed

4.2 Examples of poor setups

INCORRECT: 2x lanes high speed, the angle occludes some vehicles and misses plates

INCORRECT: Access control, horizontal angle too acute

INCORRECT: 2x lanes high speed, angles to great and incorrect zoom

INCORRECT: Access control, good camera position, bad quality images