GUIDE - Car plates reading

Our version of the facts.

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WHAT ARE THE DIFFERENCES BETWEEN TWO CAR PLAETS READING SYSTEMS?

ACCURACY COMES FIRST

Talk is cheap. All are capable of reading car plates and everyone seems to confirm that their system works perfectly. Demonstrate the real capabilities ON FIELD, we guarantee it is quite another thing! Everything can be said in the advertising world, but then account must be taken of the facts and reality. It's easy to read CLEAN and reflective car plates (especially in summer).

Damaged, warped, semi-covered characters, snow, mud, mosquitoes, backlighting ... are some examples of everyday phenomena affecting any car plates reading system. All these variables make it difficult to read and require sophisticated recognition. A system that works in fits and starts is a bad investment. That's why talk of precision is misleading if it does not refer to real data obtained by installing the system in the field (on the road) and verified in all conditions (other than those in laboratory or with clean plates).

HOW DO YOU MEASURE ACCURACY?

The index of accuracy is reported by device/system manufacturer on its datasheet. However, rarely the datasheets describe the method by which the data was obtained. One of the most widely used method is the owner one. The accuracy is calculated from internal audits carried out in laboratory. Others prefer to rely on laboratory analysis of independent bodies, which provide a test report, which certifies the accuracy class of the device: class A if the accuracy is equal to or greater than 95%, class B> 90%, class C<90 %.

Unfortunately in both cases the laboratory tests are not able to simulate the external environmental conditions in which the system will be actually operating. Laboratory tests are performed on clean, perfectly reflecting plates, with no shadows nor backlighting: in other words, under optimal conditions. It's definitely a matter of reference (as long as supplied by others), but far from demonstrating actual accuracy of the product once it is installed **on the field** (i.e. on the road). Some systems who claimed a certification class A (95% accuracy) were subsequently shown to have an accuracy of less than 60%.

There are no automated systems to calculate the actual precision of a plate reading system. The correct method still remains the *human visual analysis*, which consists in manually counting the number of car plates without errors, comparing to the total captured. This involves having to test the system directly on the road, capturing a significant number of transits (at least 15 a day for 365 days) in order to verify the system operation under all conditions (summer, autumn and winter, with fog, sun , rain, snow, day and night). A test of this type is very challenging, represents a high cost for a manufacturer and for this reason it is adopted by a few. Serious ones, however, choose to do it.

NOTE: Selea verifies the accuracy of its products through the tedious manual method of visual inspection, analyzing thousands and thousands of images captured on the road, of any type of vehicle passed, on road sections with heavy traffic for a period of time of at least 12 months (spring, summer, autumn and winter).

WHERE MISUNDERSTANDINGS ARISE

There are two kinds of misunderstanding that often cause confusion in those who have to buy a car plates reading system: one related to the technical specs and the other one to the product types.

MISUNDERSTANDING ABOUT TECHNICAL SPECS

Many datasheets of car plates reading cameras do report technical information that suggest a promising and efficient product. Unfortunately, most of these data show no correlation (connection) between them. The lack of a link hides a thousand question marks about the real conditions in which you will get the performance specifications stated on the datasheet. For example, declaring that a car plates plate reading system reads at speeds above 200km / h, with 95% accuracy, and that the viewing angle is 50 degrees, immediately makes one think that the camera provides all these benefits in the express conditions. If you ask for further information, it turns out that, yes, the camera can read car plates up to 200 km / h (as an upper limit), but at that accuracy does not exceed 10%: then at 200 Km / h it reads one car plate out of 10. To obtain a 95% accuracy, the speed should be reduced to 80 km / h and the viewing angle should not exceed 25 degrees.

A serious datasheet should report technical performances as related to the one true important feature: the final result, i.e. the reading accuracy on the field. Starting from the readability ON FIELD (and not in the laboratory), all other technical data should be associated with such accuracy. If I declare an accuracy of 95% and a reading speed of up to 200 km / h, this should mean that I get that precision at that speed, with that reading angle and in all weather conditions: whether with dirty or clean plates.

NOTE: Selea marks in its datasheets all the technical details that have correlation with each other and are closely related to reading accuracy on the field.

MISUNDERSTANDINGS ABOUT PRODUCT TYPES

With LPR (License Plate Recognition), CPR (Car Plate Recognition), NPR (Number Plate Recognition), were long ago set the PC-based systems: systems consisting of cameras + PC + software for car plates reading. With ANPR (Automatic Number Plate Recognition) were indicated, however, the new smart cameras where reading was done automatically on-board of the camera itself (without PC). Because of an unscrupulous commercial use, enormous confusion has arisen in the use of these acronyms. Today they are used, **without distinction**, the same acronyms either to denote trivial IP / analog cameras, or an intelligent camera with OCR reader installed on board. To the unsuspecting buyer, **the tricky aspect** is that many cameras are described as capable, by themselves, to read the characters. Instead, they are no more than trivial cameras endowed with an anti-glare filter, only useful to the transmission of images. To read the car plate, you must then use the PC and the appropriate OCR software to be installed on your computer. **Fortunately,** this type of cameras are easily recognizable thanks to the fact that within the technical specifications there is no mention of any type of OCR (characters reading algorithm), syntax, nor any data on the reading accuracy**.**

Warning: on websites or on the datasheet the image of a camera is often associated with the slogan of "car plates reading". This suggests the introduction of an intelligent camera with on-board OCR. After a careful reading of the site or the datasheet, it turns out that it is a PC-based system.

PC-BASED SOLUTIONS OR ALL-IN-ONE CAMERAS?

Which one to choose?

DIFFERENT OPTIONS

Many people ask us whether it is better a PC-based system - computer-based system + software + camera (analog or IP / Megapixel) + illuminator - or a system based on intelligent all-in-one camera with built-in OCR. Which one is more profitable?

To honestly answer this question, we must make a distinction between three different applications:
a) system for access control / parking - the vehicle is stationary or moving at very slow speed;
b) a system for on-road use (free-flow) - the vehicle is moving at high speed;
c) a system which requires a high number of car plates reading points ('high' means higher than 4 cameras).

According to our opinion (but also that of many other experts in the field), while for the first application field (a), the PC-based system may sometimes (but not always) be economically convenient, for road systems(b) and applications involving several reading points (c), the all-in-one is without a doubt the most beneficial.

Here are the reasons:
1) the camera with integrated OCR offers, by its nature, more precise reading than any PC-based system and this can be an important aspect even for a simple access control or for parking (which are having to manually manage missed readings);
2) the camera with built-in OCR is equipped of pulsed illuminator that, unlike the PC-based systems (which use cameras with non-adjustable illuminators), adjusts its power to every single reading (dirty / clean plates, sun / fog , day / night etc.) and this determines a significant increase of the reliability and accuracy of reading;
3) the camera with integrated OCR requires no fans or other moving parts and no air-conditioned environments, as required by the PC-based systems;
4) the camera with OCR is an integrated all-in-one solution that is simple and quick to install;
5) a PC based system is able to support the simultaneous reading of no more than 4 cameras for each workstation. So, every 4 capture points you need to install a PC. The camera with built-in OCR allows you to create systems with an infinite number of readers centralizing all on a single PC;
6) considering 150 ~ 300 watts for the PC + 15 ~ 40 Watt for the camera with illuminator, a PC-based system consumes ten times the electricity consumed by a camera all-in-one (15 ~ 20 Watt max). This means energy savings over time.

COMPARED SOLUTION NO.1

Consider a system consisting of a **Megapixel** camera with anti-glare filter. Then add the camera the infrared floodlight. Obviously, the camera system + floodlight only captures images in high resolution, but does not read the car plate. The reading of the plate is performed by an OCR software installed on computers that will process the Megapixel images to extrapolate the content.

What problems are hidden behind a solution of this kind?

The most common problems we encountered (real case) are of two types:

a) *in the evening*: the type of sensor used by the megapixel camera often does not allow to obtain quality images. In the evening, the images are often blurry or with creeping effect: phenomena that spoil the reading of the characters by the OCR software. In some cases you can run for cover using powerful IR floodlight that may generate the same problem during the day;

b) *during the day*: in some periods of the year (especially spring and autumn) the inclination of the sun is such that floods the car plate with IR rays. The IR illuminator of the car plate reading system adds IR on IR amplifying the problem of overexposure. Result: for several months, at certain times of day, the car plates reading system cannot read the car plates.

These problems are caused by two main technical aspects:

1) the use of cameras equipped with *Rolling Shutter* sensors, while *Global Shutter* sensors should be used for car plates reading;

2) the use of standard fixed floodlights (that can supply a constant power). A car plate reading system would require an adaptive floodlight with variable power, which is suitable to sunlight and the reflectance of the plate, in order to avoid over-and / or under-exposure.

COMPARED SOLUTION NO.2

Implementation of a **town car plates reading system**, with the intent to control the cars entering and leaving from different roads (a dozen escape routes). The system is built using LPR analog cameras with integrated illuminator + computer + PC-based software for car plates reading system. For reasons of installation, the analog LPR camera is converted to IP in order to reach the center.

What problems are hidden behind a solution of this kind?

Those observed in real cases are mainly two:

a) high bandwidth;

b) simultaneous reading by multiple cameras.

The problem of bandwidth arises from the need to send pictures to computers and OCR software for car plates reading. A camera with on-board OCR, however, can send already eleborated images with a high bandwidth saving.

The second problem arises because of the processing complexity of car plates reading, which requires substantial computational resources, while it is a well-known fact that a computer can support, in real time, up to 4 simultaneous computations (i.e. 4 cameras). This means that to achieve a system composed of dozens of cameras, you have to install several computers. All this translates into: a) high power consumption, b) higher maintenance costs, c) the need to cool the local PC, d) increased cost of management and security.
The cameras with on-board OCR, on the contrary, are not equipped with fans, must not be cooled, have low power consumption and allow to relieve the central computer from computing processes, offering the possibility to manage, in real time, an unlimited number of car plates reading cameras.

COMPARATIVE TABLE

Here is a comparison between a PC-based solution and an all-in-one camera with on-board OCR.

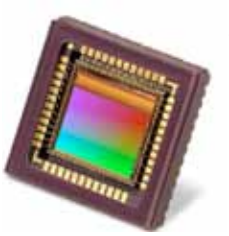
	PC Based - LPR	All-in-One - ANPR
Accuracy on road	from 60% to 90% ☆☆★★★	from 85% to 99%
No. readings per PC	4 ☆☆☆☆★	no limits ★★★★★
Computational resources required	high ☆☆☆☆★	low ★★★★★
Reliability	medium-low ☆☆★★★	high ★★★★★
Installation time	long ☆☆☆☆★	short ★★★★★
Energy savings	low ☆☆☆★★	high ★★★★★
Maintenance costs	high ☆☆☆★★	low ☆★★★★
Floodlight	Fixed IR ☆☆☆★★	Adaptive IR ★★★★★
Bandwidth	high ☆☆☆☆☆	low ☆★★★★
Temperature	0 ~ +30°C (standard PC)	-25°C ~ +50°C

WHAT ARE THE CRITICAL COMPONENTS OF A CAR PLATES READING SYSTEM?

THE CAMERA

There are two technical aspects to be taken into due consideration when buying a car plates reading camera, be it for PC-based system or all-in-one: the type of sensor and its resolution.

SENSOR



To get good reading results, you need the camera to be equipped of a sensor called *Global Shutter* in technical jargon: it is a sensor in which the acquisition of the pixels is simultaneous (flash), other than the sensor *Rolling Shutter* , in which the acquisition of the pixels is sequential (one after another). The Rolling Shutter sensor has a much lower cost compared to the Global Shutter and it is widely used in cameras for standard surveillance.

Using a simple anti-glare filter (light), standard cameras can be turned into shooting equipments also used for car plates reading. The latter, even if adapted, produce images with "creeping" effects in the presence of moving objects such as vehicles, giving rise to erroneous reading of the plates. To overcome this problem, some companies use powerful IR illuminators, which involve increased costs and risk (due to the presence of the sun) to generate serious problems of over-lighting during the day. Intelligent all-in-one cameras with built-in OCR only use Global Shutter sensors.

RESOLUTION

What is the advantage of using a camera equipped with a 100 pixels sensor rather than a 3 megapixel one, then if the performances of car plates reading are identical in all respects? And we mean, the same accuracy and quality in the *same gate width*? Technically speaking, none, although commercially speaking the megapixel camera is often considered as a "superior" product. It should be specified that there are cameras with VGA sensors capable of performing the same task of megapixel cameras. The truth is that some ANPR cameras manufacturers are forced to use Megapixel sensors to hide a defect: that of owning a very poor algorithm for character recognition (OCR): quality algorithms can in fact recognize a character with few tens of pixel-sensor (20 pixels). Poor algorithms do need, however, also of 100-120 pixel-sensor. Less resolute sensors (such as VGA) have a higher capture rate and sensitivity than Megapixel sensors and this is a better feature. Do not be fooled by appearances on the question of "resolution." Read well between the lines. What matters to you, after all, is the end result!

THE IR FLOODLIGHT

The floodlight is **one of the most important components** of a car plates reading system (be it PC-based or all-in-one). It contributes 50% of reading accuracy. The most commonly used lighting system is the classic IR spotlight with constant emission. *Well, what is an IR floodlight?*

It is used to illuminate the car plate and counteract the glare of the headlights.
In order to eliminate the blinding glare of the headlights, car plates reading cameras use a filter that blocks the visible component of light, leaving open only one window that passes only infrared rays (emitted by the headlights only minimally). Removing the visible component of light, the anti-glare filter makes the image completely dark and therefore it is essential to illuminate the plate with an IR spotlight. There are two types of IR floodlights: constant emission ones (the most common) and self-regulated ones.

It is well known that a good photographer who wants to accomplish his work must constantly adjust the light of a flash unit according to that already present on the subject and in function of the contrast and any backlight. Only by acting on these parameters he is sure to get a good picture ... and a good image, in our case, allows a good reading of the plate. Similarly, then, should act a car plates reading system (camera + floodlight). Illuminating a plate already flooded with infrared rays from the sunlight, adding other rays with IR spotlight, means putting it in over-illumination. This is what happens to those who make use of IR floodlights with steady light (the standard ones, for instance). The light forcar plates reading systems should, on the contrary, read the lighting conditions on the plate and automatically adjust the emission power. A plate just emerged from the car washing will reflect in a different way compared with a plate still dirty and covered with mud, which passes in front of the camera a second after the first one. In the first case, just a minimum power is needed, while in the second case we need a large amount of infrared to overcome the barrier of dirt and read the characters.

This is the reason why manufacturers of intelligent cameras with on-board OCR resorted to *adaptive* floodlights. These are fitted with automatic adjustment of the emission intensity which varies in function of the amount of radiation reflected from the subject and that present in the environment.

NOTE: Our Targha cameras, as well as using adaptive floodlight, have the additional feature of image analysis. It's a simple but unique process. Analyzing each frame, the "brain" of Targha provides the floodlight the correct intensity value. In other words, the camera examines every single frame and acts on the floodlight in such a way as to obtain the best image possible.

THE OCR AND THE CAR PLATE'S BODY

There are different ways to read car plates, even if the ultimate goal is to identify the car plate's "body" and distinguish it from advertising signs, symbols, labels and other objects on the vehicle. This is one of the most difficult tasks that require sophisticated algorithms. For this reason, many systems still fail in this research.

The most poor ones find it difficult to find the car plates that are off-axis from the center of the vehicle (for example, do not read the front plates of the Alfa Romeo - see the picture above), while others cannot distinguish advertising from the written characters of the plate.

However, once recognized the car plate's "body", a well-made car plate reading system brings into play further algorithms of analysis, including:

- Characters Recognition (OCR);
- shadows removing;
- dirty plates treatment;
- exclusion of the symbols within the car plate's "body";
- characters shape recognition, which differ from Country to Country;
- and many more ...

All these processing, necessary for a successful reading, require a strong computational effort.

If you omit even one of the above data processing, you will get a satisfactory result only with clean plates and uniform lighting conditions, but very poor one in real conditions, with dirty, faded, warped, in the shade plates, with advertising signs, etc. .

THE SYNTAX

Some car plates reading systems integrate the function of syntax recognition, which would, in theory, define the Nationality of origin of the vehicle.

Unfortunately, the lack of an ordering among Nations make this feature practically unusable. The errors that are created, due to the lack of rules, are not at all negligible: French car plates present more than 12 different syntax

types; German ones as well; English car plates exceed 15. In some Countries you can even custom car plates, so that the syntax becomes not definable. Several Nations have syntax types which are equal to each other and therefore it is impossible to identify the correct source. In our opinion, it is far better for a car plates reading system to focus on a perfect reading of the plate rather than on something of little practical use.

Why, then, some car plates reading systems pride to incorporate the syntax?

A method for discriminating advertising signs from those contained in the car plate's "body" consists in the use of syntax. Without this logic some systems would not be able to locate it, thus generating a multitude of reading errors. The syntax is often disguised as a plus, but actually serves to compensate for the inability of the system / device to recognize the car plate's "body" from other objects. The syntax requires the acquirer to be subject to limitation of syntax libraries built into the camera (often limited to a few Countries) or to buy the extension libraries. The modern and better plate reading systems, so-called Sintax free, guarantee a high recognition accuracy without the aid of any syntax, nor of libraries.

WHERE DO SYSTEMS FAIL? Analysis on field

Shadows on the car plate may have different tilt (horizontal, vertical or oblique), intensity (weak or strong) and aspect (uniform or inhomogeneous). A standard car plate reading camera is not always able to solve the problems, as a mix of regulations is necessary, involving the adaptive floodlight and sophisticated video-analyses algorithms.

PROBLEM: SHADOWS

real images

During many times of the year, an excessive quantity of sunlight (which includes infrared rays) may cause an over-exposure of the car plate's reflecting parts. Adding more rays, as standard floodlights do, would be the worst thing to do.

PROBLEM: OVER-EXPOSURE

real images

Creeping effects may prevent a good car plate reading. Megapixel sensors are often subject to this kind of problem, especially in case of low light. Using a powerful spotlight may solve the problem during the night, while the daylight may cause over-exposure problems. That is why it is far better to use suitable Global Shutter sensors.

PROBLEM: CREEPING EFFECT

real images

The so-called “smeering” and “blooming” effects may prevent a good car plate reading. These effects are caused by CCD-sensor-endowed cameras or by chrome and highly reflective surfaces. The best solution consists into using high-frame rate CMOS Global Shutter sensors.

PROBLEM: REFLECTIONS

real images

Front car plates are generally subject to the most serious damages, due to frequent collisions with walls or stones. Even seriously damaged car plates can be read by intelligent algorithms based on the predictability system.

PROBLEM: DAMAGED CAR PLATES

real images

Car plate reading cameras may face a situation in which dirty plates quickly alternate with clean and bright plates. It is very important in this case to use pulsed and adaptive floodlights which adjusts to the light conditions, the plate’s reflectivity and the IR rays within the environment.

PROBLEM: DIRT

real images

IN SHORT

Let us summarize the above contents in a concise list:

- Shadows, backlighting, dirt, snow, rain, crumpled plates are the great enemies of a car plates reading system;
- The ROAD accuracy is the only useful element for understanding the quality of the product;
- PC-based systems are often less profitable and accurate than all-in-one solutions;
- All-in-one cameras with on-board OCR are the best solution that today's technology makes available to us;
- The syntax is not a plus, but a bond that offers no real advantage;
- Be careful of acronyms ANPR, LPR, NPR, etc.. as they often hide uncomfortable surprises;
- Attention should be paid to data reported about performance to make sure they are related to reading accuracy and among them;
- Too poor datasheets must be looked at with suspicion, as they often hide uncomfortable truths;
- The more algorithms the device integrates, the greater the likelihood that the product the gives us excellent reading results.

TARGHA

Reading passion

...seeing is believing!

We challenge anyone to read so well

The pictures in this document are original (taken from SELEA's Targha camera). Being a public document, some characters have been deliberately hidden or deleted for privacy reasons.

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