Parameter definition of the camera settings and of recognizable object in the system of automatic video recording

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Abstract

The article describes the calculation of geometric dimensions of the object in pixels, as well as technical requirements for automatic video recording camera and the distance to the object. The authors suggest and apply the algorithm of the search of object's boundaries.

Keywords: recognizable object; fine details recognizing; automatic video recording; camera settings

1. Introduction

The problem of a video camera selection for the purpose of recognizing of fine details, the identification of the person's face and recognizing of license plates of cars is connected with certain difficulties, that not always convenient to be guided only by the value of the focal length. The issue at stake requires determination of camera view on the proposed installation distance from the object of observation, the definition of the screen area occupied by the object, and sufficient detailization of small objects. Based on the data, the determination of lens focal length for the camera have been made.

2. Calculation of geometric dimensions of the object

To recognize the car state registration plates standard analog camera had been used. The camera should have a high resolution (500 TVL), manual exposure (shutter).

Focal length should be adjusted so that the car license plate in width on the analyzed video would occupy no less than 140 pixels horizontally. This is the average parameter used in the majority of automatic identification systems. Knowing the size of the license plate - 520x112 mm, it is possible to calculate the pixel size - 140h30. These dimensions can be varied in the range 120-180 horizontally and vertically 14-30, depending on the resolving ability of the camera.

Fig. 1. License plate in the analyzed picture.

The size of each character can also be calculated based on the actual size of the license plate.

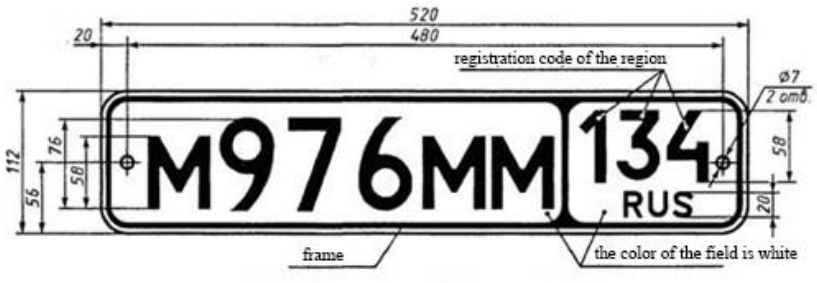


Fig. 2. Parameters of the license plate.

Knowing that the license plate has 9 characters, about the same horizontal size, we could find that each character is about 50mm, after deducting the distance between the characters. Therefore, the character size in pixels would be calculated from the ratio of 520/50 = 140 / x. Where x = 13 px. 140px horizontally taken as an average.

3. Technical requirements to the automatic video recording camera

Calculation of distances is based on European standards requirements for CCTV [1]:

- linear resolution for object detection - 20 pixels / m;
- linear resolution for the recognition - 100 pixels / m;
- linear resolution for identification - 250 pixels / m;

The resolution of video camera's matrix 1080 (2Mp Full HD), 700, 560, 480, и 380 TVL.

To obtain correct results it is necessary that the whole measuring circuit (Camera - Cable - Monitor) was, as far as possible, of the minimum length and the maximum quality. Measuring table should be evenly covered. To obtain the results, which are close to reality, measurements at different light conditions, such as 1000, 100, 10 and 1 lux (for this purpose light meter and adjustable light source are needed) should be carry out.

It should be taken into consideration, that due to the presence of strong distortions in the short-focus lenses, the viewing angle can differ from the calculation.

The greater the distance from the camera to the subject, the greater the depth of field, so there is no need to place the camera too close to the detection zone. On the other hand, the greater the focal length, the smaller the depth of the field. The optimal distance from the camera to the object is in the range of 6 to 10 meters. Although, recognition distance of 100 meters is rather possible.

Many lenses distort the image a bit. The most common is so-called "barrel-shaped" distortion of the image. This is due to an increase that is greater in the center and less at the edges, which changes the size of the object. Thus, if the same object in an image falls on the center and the edge - the edge of its dimensions will seem smaller. This may affect the possibility of identification.

It is recommended to use the black / white camera as it has a greater, compared with color camera, resolution and sensitivity. Image made by color camera is converted to black and white for recognition purpose.

The shorter the focal length, the more can be significantly distorted. Therefore, using the camera with wide-angle lenses (less than 4mm) for identification purpose is undesirable.

4. Light-sensitivity and shutter speed

For reliable detection of car registration plates, the camera should have good sensitivity and the ability to manually set the shutter speed (shutter speed or a shutter). This requirement is very important in the construction of systems of recognition of license plates of cars moving at high speed. For vehicles moving at speeds of up to 30km / h (namely such projects we implement and sell for our customers: cottage villages, housing estates, car parks shopping centers, various closed areas), this requirement is equally important, it should not be underestimated, because to achieve the high quality recognition the camera should produce at least ten frames with readable license plates.

Therefore, for example, to recognize license plates of vehicle, moving at a speed of 30 km / h at an angle of the camera settings to 10 degrees relative to the axis of motion, the shutter speed should be about 1/200 of a second. For many inexpensive cameras such exposure, even in cloudy weather during the day may not be sufficient, and the picture will be dark and / or noisy. Therefore, you should pay close attention to the size of the matrix and its quality. Ideally, use a dedicated black-and-white camera with a CCD matrix. However, the cost of such camera is very high and resolution is usually not more than 1MP that imposes serious limitations on their applicability.

In general, do not chase the high resolution, if there is no objective reasons. The ultra-low-cost high-resolution camera (4Mp, 5MP and above) are constructed on the matrix 1/3, 1 / 2.8 and less than 1 / 2.5 inch. The same size of the matrix have cameras with a resolution of 1.3 and 2 megapixel. As a consequence, the size of each photosensitive element in 1.3 megapixel camera significantly greater than in 5MP cell size camera and the more the size - the more light each photosensitive element could gather. That is why recommended for recognition of license plates IP cameras rarely have a resolution of more than 2 megapixel [1].

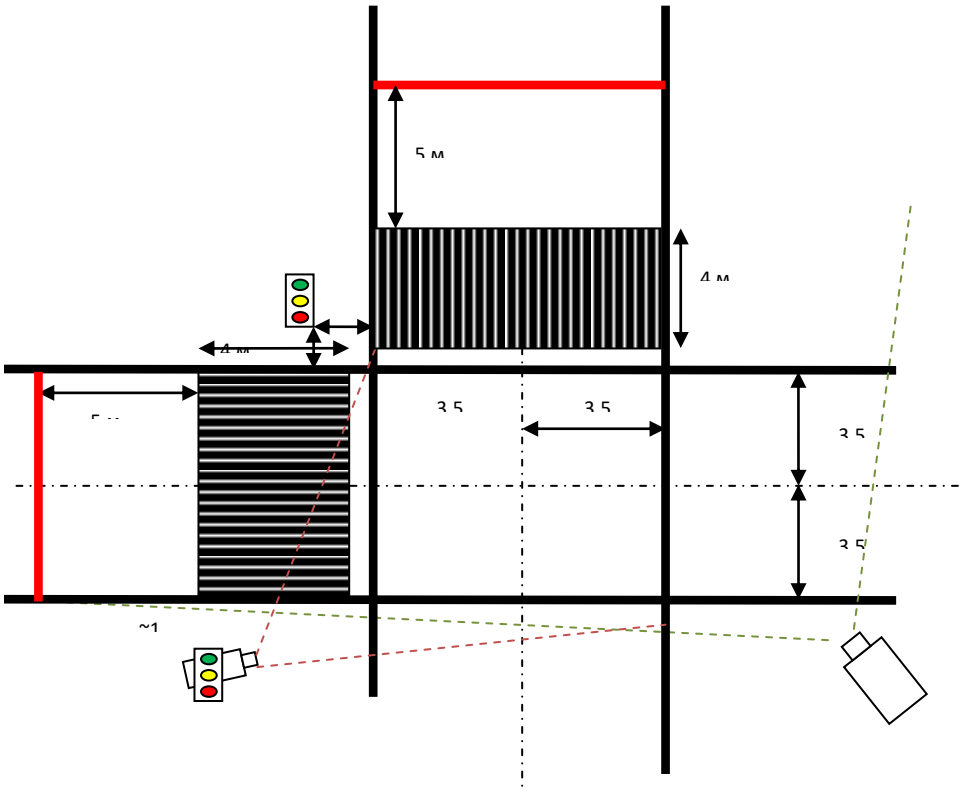


Fig. 3. Road lay-out.

5. Wide dynamic range (WDR), compensation of background illumination

The dynamic range of the camera determines the ratio between the maximum and minimum light intensity, which can fix its sensor normally. In other words, it is the camera's ability to pass without distortion or loss of both brightly lit and dark areas of the image. This setting is important for automatic recognition of license plates, because it helps fight with illumination of camera lights by flare light. However, even the most advanced cameras with WDR to 140dB are not always able to cope with high-contrast lighting. In this case, an additional set of visible light illumination is needed, or working in the infrared, which is illuminating the area where the license plates' recognition takes place.

While selecting the camera, you should pay attention to the model of the hardware, not the software mechanism, for expanding the dynamic range, based on 2-fold picture taken with different exposures. This camera takes no less than 50 (60) frames per second and "glues" every couple on the processor level. Such cameras are much more expensive, but their efficiency is worth it.

6. Depth of field

Depth of field, or fully with a depth of field of field (DOF) is the distance range in which objects are perceived as sharp.

This parameter is determined by the focal length, aperture and distance of the object. The greater the depth of field, the more the focus area and the more opportunities to "catch" a sufficient number of clear shots of a moving car.

Perhaps the greatest impact on the depth of field has a lens aperture. The smaller the aperture, the greater the depth of field, the more - the less depth of field. All recommended camera for recognizing license plates are able to adapt to changing lighting conditions by automatically changing the aperture. It is recommended to set the focus of the cameras at maximum aperture, when the depth of field is minimal.

The greater the distance from the camera to the subject, the greater the depth of field, so it is better not to place the camera as close to the detection zone. On the other hand, the greater the focal length, the smaller the depth of field. According to our experience, the optimum distance from the camera to object is ranging from 6 to 10 meters. Although, recognition could be made at 100 meters' distance.

7. Distortion

Many lenses distort the image a bit. The most common so-called "barrel-shaped" distortion of the image. This is due to an increase that is greater in the center and less at the edges, which changes the size of the object. Thus, if the same object in an image falls on the center and the edge - the dimensions on the edge will seem smaller. This may affect the possibility of identification.

The shorter the focal length, the more can be significantly distorted. Therefore, the camera with wide-angle lenses (less than 4mm) for identification is undesirable.

8. Noise and color

The less noise and the more accurate color rendition - the better to identify. Therefore it is recommended to pay attention to such parameters as the minimum illumination of camera, as well as the presence of noise reduction functions.

Noise reduction is especially important in low light conditions, when the camera sensors are "making noise" much, which complicates identification. It should be understood that in many cases, noise reduction and other electronic "gadgets" can not cope, and it is necessary to ensure an adequate level of lighting at the object.

9. Compression of video

Modern IP-cameras transmit compressed video signal, and if there is no motion in the frame or it is minimal - the traffic will be small. If the movement in the image heavy - the traffic will grow. Therefore, in the case of nominations to the chamber constant bit rate settings, the picture will be useful for identification in the absence of movement, but unsuitable in the case of heavy traffic in the frame.

For the purpose of identification it is recommended to set the variable bit rate with the highest level of quality. In this case it would provide the desired quality of image.

10. Algorithms of borders' detection

Almost everything can be divided into two categories: methods based on the finding of the maxima and methods based on the finding of zeros. Methods based on a search highs, isolate border by calculating the "edge strength", they are usually the expression of first derivative, such as the magnitude of the gradient, and then search for local maxima edge strength, using the intended direction of the border, usually perpendicular to the gradient vector. Methods based on finding zeros, looking for the intersection of the horizontal axis of the second derivative of expression, usually zeros or zero Laplacian nonlinear differential expression, as will be described hereinafter. As a preprocessing step to the border selection is almost always anti-aliasing of image applied, usually by Gaussian filter.

The most obvious method of allocating of license plate is a search rectangular contour. It works only in situations where there is clearly readable outline, no fenced, with sufficiently high resolution and with a smooth boundary.

Image is filtered in order to find the borders and then extracting of all found contours is made and analyzed. (Fig. 4)

Circuit is initialized as a simple line, then it is deformed to create the area of an object. The points in the circuit tend to the border of the object when the contour energy minimizes. For each point the energy [2]:

$$E_i = \alpha E_{int}(v_i) + \beta E_{ext}(v_i),$$

where α, β — constants, providing a relatively energy correction;

$E_{int}(v_i)$ — function of energy, depending on the shape of the contour;

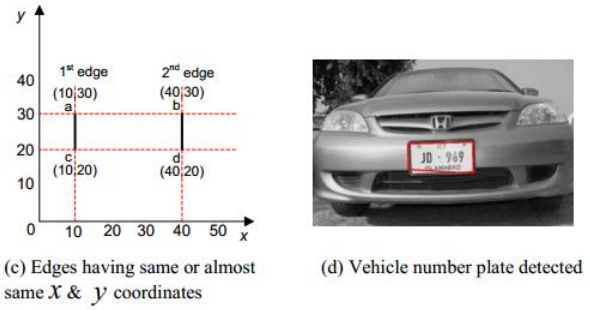
$E_{ext}(v_i)$ — function of energy, depending on the properties of the image and type of gradient in the neighborhood of point v_i.

Values E_i, $E_{int}(v_i)$ и $E_{ext}(v_i)$ are square matrices. The value in the center of each matrix corresponds to the contour of energy in the level v_i. Each vertex v_i could potentially go to any point, v_i' corresponding to the minimum energy.

Fig. 4. Detection of rectangular outline.

11. Detection of borders' parts

The authors suppose as more stable approach the one, where the analyzes is made for only part of license plate brow. Contours are detected and then all vertical lines are found. For any two lines located close to each other, with a slight shift along the y-axis, with the correct ratio between the two distances to their length, the hypothesis is that the license plate is located between them. In fact, this approach is similar to the simplified method HOG (Histogram of Oriented Gradients).



(c) Edges having same or almost same x & y coordinates

(d) Vehicle number plate detected

Fig. 5. Analysis of the parts of the borders.

12. Histogram analysis of regions' characters

One of the most popular methods of approach is the analysis of the histogram of the image. The approach is based on the assumption that the frequency characteristic of the region with a number is different from the frequency characteristics of the neighborhood.

Allocation of borders in the image is made (the selection of high-frequency spatial components of the image). A projection image is constructed on the axis y (and sometimes on the axis x). Maximum of projection obtained may coincide with the location of license plate [3].

This approach has a significant drawback - the size of the car should be comparable to the size of the image's size, that is, the background may contain labels or other detailed objects.

The drawback of all previous methods in that in the real, dirty license plates there are no borders, no pronounced statistics. Below is given a couple of examples of such license plates.

Fig. 6. Heavily fouled license plates.

13. Conclusion

Many of the techniques in real algorithms directly or indirectly rely on the availability of license plates' borders. Even if borders are not used for detecting license plates, they can be used for further analysis.

For statistical algorithms it could be rather difficult case even a relatively clean license plate in chrome (light) frame on a white car, though it occurs much less often than dirty license plates and there could be no sufficient amount of such cases for teaching.

Most of the above-mentioned algorithms do not detect characters in license plates accurately enough and require further clarification of their position, as well as improving the quality of the picture (image).

With a significant license plate's pollution, periodic peaks in the division on the characters simply could not occur, even though the characters themselves can be quite readable visually.

Horizontal border (brow) of the license plate is not always a good guide.

License plates could be bent nominally (Mercedes C-Class), they could be carefully recessed into the wrong nearly square recess for the license plates on the American cars. And the upper brow of the rear license plate is often covered with the elements of the body.

To address all of these issues is a serious problem for plate recognition systems.

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