Camera testing technique for auto recognition

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Abstract. The article describes the methodology for testing various cameras for their use in systems using neuro intelligence. This task is vital since the effect of the artificial intellect in recognizing incoming images is highly dependent on the quality of the input image. For these purposes, a detailed review of all relevant parameterization of measures in their assessment is given. The article can be useful for creating new systems oriented to the analysis of video images with a selection of cameras. The given method has been tested on real cameras and described in the article.

1. Introduction

One of the tasks of creating systems for processing and analyzing data using neuro intelligence comes down to choosing the cameras used in the system by comparing cameras of various types from different manufacturers under the same conditions [6]. The relevance of this study is due to human life practices, including the development of security systems, media and communication technologies, the organization of the educational process [1, 2]. As the studies showed, even simultaneous shooting with several cameras at the same time does not provide objective information for a specific camera. This fact is because the automatic mode of the software of the camera itself always works unpredictably and in real life, everything is continually changing.

2. Stand

Testing, as part of the work, was carried out in a specially prepared laboratory on a test bench, for which the standard world system shown in Figure 1 was applied.

A room completely isolated from external light was used, with a stand – a poster, shown in Figure 1, illuminated by six lamps of 600 W each.

Lighting was measured with a special luxometer in four positions of the lamp regulator. This illumination corresponded to standard situations in which the use of the finished system as a whole is planned in the future. We tested the infrared illumination of the cameras (where it was present) in poor lighting conditions (130 lux), and in the dark, this is shown in graph one by the corresponding divisions along the X-axis – 130 and 1 lux.

For each lighting value, a camera mounted on a tripod took two pictures, from which the best one was later selected for measurements.
Figure 1. The standard world system used in testing cameras developed by Vivo

Besides, a resolution was set for different distances from the camera. For this purpose, the camera was placed at distances from 0.5 to 30 meters from the stand in increments of 0.5 meters at a distance of 15 and 1 meter between 15-30 meters. The resolution of the camera was estimated according to the radial worlds, which in the stand of 7 pieces.

3. Measurements

It should be noted that this refers to the real resolution of the camera. That is, it refers to a bunch of optical systems + sensor + software.

Those values indicated in the technical specifications of the camera are the size of the output image in pixels. At the same time, the actual resolution of the optics may differ from this value, both upwards and downwards.

There may be a change due to all the components of a modern camera: sensor, optics and control software.

For determining the numerical value of the resolution in a picture with the world, it is necessary to determine the size of the defective region in its centre, i.e. determine the size where the rays of the worlds are indistinguishable. Usually, it was a fairly clear and distinguishable border. However, if it is difficult to determine it, the average value was chosen, it can be seen in more detail in Figure 2. Its diameter (D) in centimetres is taken as a linear parameter of the defective area. After that, the calculation of the value of R is carried out according to the corresponding formula:

\[
R = \frac{120 \times L}{\pi \times D \times P},
\]

where, L is the length of the image in centimetres; D is the diameter of the defective region in centimetres, P is the number of points along the long side of the image in pixels 120 is the number of rays in the world; \(\pi\) is the number of PIs with an approximate value of 3.14.
The Resolution option is in lines per pixel. This parameter is a universal and relatively objective characteristic used in comparing cameras. The cameras will work in systems with artificial intelligence, with objects located primarily in images. Therefore, objects at the edges of the stand can be omitted in this study.

However, almost always the resolution at the edges of the camera is significantly lower than the resolution in the centre. The maximum theoretically possible value of resolution in lines per pixel is one. Today, for perfect cameras, this parameter is in the region of 0.9 lines per pixel.

4. Other parameters and their assessment

It should be noted that resolution is not the only parameter by which cameras can be compared and rated:
- Color rendition;
- exposure selection;
- noise;
- Speed autofocus;
- Noise reduction operation.

These parameters have little effect on the work of artificial intelligence in the future, and it is difficult to convert them into numerical values. This approach reduces the comparison to an unscientific “by eye” approach. Naturally, the “resolution” parameter cannot adequately assess the camera, and therefore field tests with images in real conditions were also carried out, an example is shown in Figure 3.

The work of the camera with noise in complicated shadows, sharpening, and other parameters, due to the lack of the possibility of an objective assessment, we shifted to the AI system itself. All “field” images were worked through the AI system (Fig. 4) to determine the possibility of the direct operation of the camera itself in “field survey” mode.
5. Conclusions
As a test bench in practice, we tested several cameras both theoretically and with the consideration of their images through recognition systems. The results are presented in Figure 5.
Figure 5. Generalized indicators of camera resolution depending on illumination

Redline. Almost perfect cameras. They give proper resolution regardless of the lighting, and in poor lighting, they are helped by infrared illumination. The average resolution is also quite high. Such cameras can be used in difficult conditions of underground mines as one of the elements of the integrated monitoring system for mining and geological works [3, 7-9].

Blueline. The most common curve for good cameras. They do great in good light and somewhat worse in poor lighting. A small dip in poor lighting indicates the faulty operation of software noise reduction.

GreenLine. Not the best cameras, but not the worst. In good lighting, they give not the highest, but stable results. If wrong, they already work much worse. The failure of the resolution of the camera in low light, that the sensor does not cope well with high values of photosensitivity, and noise reduction considerably worsens the situation, making the image blurry. Also, the camera may not have infrared light.

Turquoise line. Bad cameras. At the slightest deterioration in lighting, the resolution begins to fall, and the backlight may be absent or practically not work. A relatively low initial value may indicate poor optics, a poor sensor, or poor software performance.

According to the studies carried out within the framework of the work, the resolution value of 0.5 line/pixel is the limit after which artificial intelligence is not able to perform image processing for error-free processing.

Along with this, a comprehensive study of the system using system analysis, mathematical modelling and programming is necessary [4, 5, 9].

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