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Car rest-view mirror holder position determination by an industrial camera

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Abstract Presented article occupies with the position determination possibility of few types a car rear-view mirror holder placed on a windscreen. The aim of experiments was to verify a possibility of holder scanning and to reliably determine their location. Holders are placed on the glass with black printmaking. According to this experiment recommended adjustment of each component for future position determination by an industrial camera was set.

Key words: car rear-view mirror holder, localization, industrial camera

1. INTRODUCTION

The need of industrial camera localization occurred together with the mechanism for an automated adhesion inspection of a car rear-view mirror holder preparation. Rear-view mirrors are currently often placed on a windscreen. Each of this glass screens has its holder, which is stick on it during the production process. This attachment is unfortunately not perfect, holders are often braking away by subsequent production.

According to this problem, a device which allows on-line testing during a production process was developed. Holder is put into a clamping jaw and then tested by a defined torque load. Because of significant inaccuracy of previous sticking it was necessary to consider an industrial camera localization, which allows additional correction of a positioned glass. The mechanism is in detail described in [1].

The aim of experiments was to verify a possibility of holder scanning and to reliably determine their location on a glass with black printmaking. The accent was put on the localization of black holders on the black printmaking.

The primary aim was to find a suitable hardware and software solution of the detection. The other objective was to set the sensitivity of proposed system to boundary conditions change. Scanning and localization possibility is currently still being improved on the department of glass producing machines and robotics.

2. CURRENT SITUATION OF MACHINE VISION

Machine vision and industrial cameras sets presents new branch in production line automation field. It is surely becoming more popular, especially because they bring a considerable saving in production costs. The most common is to use machine vision for a quality inspection, where it brings faultlessness for dispatched products. Another no less common application is using of eye-hand coordination system, when a robot is directly guided by an industrial camera.

Basic question is, of course, achievable accuracy of measurement. Forming parts usually have the tolerance level of hundredth of millimetres. Machined parts often dispose of micrometers tolerance level. Even this is possible to achieve with an industrial camera, however it is necessary to know all difficulties of used methods. Parameter of camera, which determines measurement accuracy, is resolution (number of the smallest displayable points - pixels) of its video chip. Modern industrial cameras are able to use subpixel resolution. Thanks to that it can set the parts edge location to approx. 1/20 of pixel. Pixel size 5μm2 is nowadays requirement accomplished by common VGA camera with chip resolution 640x480 pixels.

Successful scanning of distortionless image is conditioned by a choice of corresponding illumination. It needs to be homogenous and stabile to set the same conditions of measurement. Furthermore, it is necessary to choose correct colour and intensity of illumination and to eliminate an influence of other uncontrollable sources of illumination, such as sun light, workplace illumination, etc. Scanning of transparent materials, for example glass products is more complicated, especially because of reflection presence. It is often necessary to choose right combination of more types of illumination (area array, backlight, ring illuminator, arch illuminator, diffuse light illuminator, multi-axes illuminator ...).

Essential influence for obtained accuracy is set by used optics. There is a perspective distortion used for spatial measurement. Outlying part of object seems smaller than the other closer to camera. Perspective distortion is corrected by telecentric lens. Thanks to it line segment is projected in the same length to the camera chip, no matter how far it is. Telecentric objective is quite expensive, mainly because the income lens diameter must be even

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bigger than visual field diagonal. However it is more difficult to extinguish other optical faults for objectives with bigger lenses [3].

Measuring under the stabile conditions (for example when a part is located by robot), it is possible to avoid using expensive optics. Calibration method is used. That means, that potential faults are compensated by software, using a comparism with another part considered as an etalon.

One of the main parameters, which affect directly the maximum accuracy of measurement, is cameras resolution. This is currently from 640x480 up to 4872x3248 pixels for standard industrial cameras. The most common resolution is nowadays 1028x768 pixels. That is appropriate compromise between a price and performance [4].

News presented in an industry are 3D industrial camera, which is able to scan 3D shape of a product. This is being used for tasks, where each part of a final product is in the same colour, eventually contrast, or it is required to know spatial dimensions (for example volume measurement) [5].

Data taken by industrial camera are processed by acquisition software. Basic operation for image processing is tresholding. For the case of 2D grey scale image, which is represented by pixels with value 0 to 255, the tresholding value is set. All pixels with actual pixel value lower then a treshold value will appear as pixel value 0 (black colour), all pixels with their actual value equal or higher then a treshold value will subsequently appear as value 1 (white colour). The image is than represented only with values 0 (black) and 1 (white). This binary object is later on treated with software filtres, which can replace or supplement physical filters on an industrial camera [6].

3. EXPERIMENT

The arranged experimental workplace (fig. 1) consists of:

- The industrial camera with flat Basler chip and specification [7]:
  Camera type: BASLER A622f
  Resolution: 1,3 Mpx
  Frames per second: 25 fps
  Interface: IEEE 1394
  Spectrum: visible
  Senzor: CMOS
  Colour range: monochrome

- Objectives:
  Objective FUJION f = 12,5 mm (HF12.5SA-1)
  Objective FUJION f = 25 mm (HF25HA-1B)

- Illumination:
  The intensive flat red light (area array 83 x 156 mm),
  Coaxial red illuminator (75 x 75 mm),
  Ring illuminator (Ø 100 mm).

- Data were processed by software NI Vision Assistant 8.5.
  Software camera setting: brightness: 126
  shutter: 1700
  gain: 200

Experiment was at first done primary in dark, to avoid a distortion from other light sources. To optimize boundary conditions, there were two objectives used. The first one was a Fujion objective with focal length of 12,5 mm, the other one was Fujion as well, but with its focal length of 25 mm. In the first step we used the first objective (diaphragm not specified yet) and side illuminator to set the experimental sequence parameterization for holders detection. During subsequent experiment we also used the other objective with f = 25 mm. The different diaphragm was set for each illuminator use to verify the adjustment stability.

Fig. 1 *Experimental workplace*

The script was incrementally improved during the experiment and the final version is shown of fig. 2, by block diagram form. Images of executed modifications are show on the other figure (fig. 3). Numbering used in the diagram correspond to image numbering and description bellow as well.

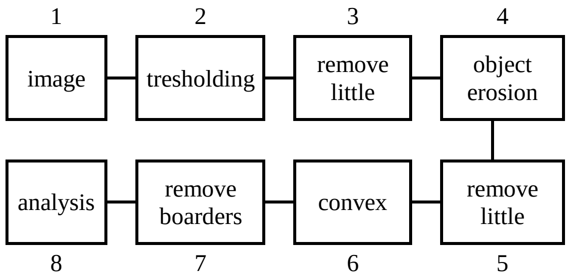

Fig. 2 *Final script*

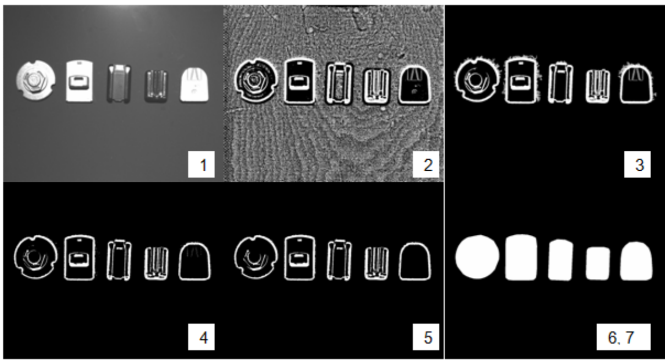

Fig. 3 *Individual steps of the script*

Individual steps of the final script:
1. Image obtained by the industrial camera.
2. This step makes Niblack tresholding, deviation factor was experimentelly set to 0,2, object size estimated to 30 x 30 mm.

Niblack tresholding algorithm belongs to local adaptive tresholding methods. Local adaptivity means that local image characteristics on the certain tresholding value are used. According to Niblack there is arithmetic mean m and standard deviation s counted in a reasonable surrounding of each pixel. Treshold T is than defined as T = m + k * s, where coefficient k is usually set to k = -2 [8].
3. Parasitic object caused by noise appears in holder surrounding. Their removing is required, and it is performed in this step. At first 4th iteration is set.
4. Erosion of the object is done in this step, 1st iteration and surrounding size 3x3 is set.
5. Ones again removing of parasitic objects in holders surrounding. 2nd iteration.
6. This step makes a convex of taken objects, which means that it fills them up with white colour.
7. This step removes objects, which lies on the boarder of the image. It is possible to eliminate reflections caused by some type of illumination.
8. Final analysis, software sets the quantity of holders. The location of each is determined by its geometric means coordinates.

Subsequent experiments with the prepared script were realized in these steps:

- Suitable illuminator selection,
- optimal illuminator placement selection,
- the various objective influence,
- the various diaphragm influence and
- the objects orientation influence to a successful detection.

4. EVALUATION

The aim of this work was to surely identify few types a car rear-view mirror holder placed on a windscreen. As it was considered, detection of silver holders on black background was relatively easy; however problem came with black holders detection on a black background. It was determined, that the most expedient is to use red area array illuminator angled to 70°. Holders identification was then quite stabile, problem occurred only for holders turned more than 20° from perpendicular. This could be eliminated by two added illuminators. This is not relevant for our case, holders are turned up to ±1,5°.

Recommended equipment and its adjustment

- Camera type: BASLER A622f.
- Illuminator: Intensive red area array illuminator (83 x 156 mm).
- Illuminator location: Angled (70°), up to 1 m from holders.
- Objective type: FUJION HF25HA-1B (f = 25 mm).
- Recomm. diaphragm: 1/11.
- Object orientation: Object needs to be illuminated from above or underneath with maximum turn of ±15°.

Identification accuracy

The accuracy of identification was set by difference of real objects centres location and centres set by software. Table 1 shows an example with the biggest inaccuracy of done experiments. Centres coordinates were set by software and recounted from pixels to milimetres. Maximum difference was 0,82 mm. It is recommended to do more experiments for eventual new types of holders.

Tab. 1 *Holders centre identification*

		Holder				
		1	2	3	4	5
Real centres coordinates [mm]	x	20,00	58,23	92,20	122,89	155,22
	y	68,09	70,56	69,87	69,60	69,32
Coordinates set by software [mm]	x	20,69	57,95	92,20	123,16	155,08
	y	67,95	70,56	70,69	69,60	68,64
Coordinates difference [mm]	Δx	0,68	0,27	0,00	0,27	0,14
	Δy	0,14	0,00	0,82	0,00	0,69

There is a figure 4 attached to show scanned holders by different diaphragms. The picture shows the first and the penultimate step of algorithm. The first image (on the left) is basically only an image taken by an industrial camera. Images on the right side shows identified holders as objects, from the centres coordinates are set.

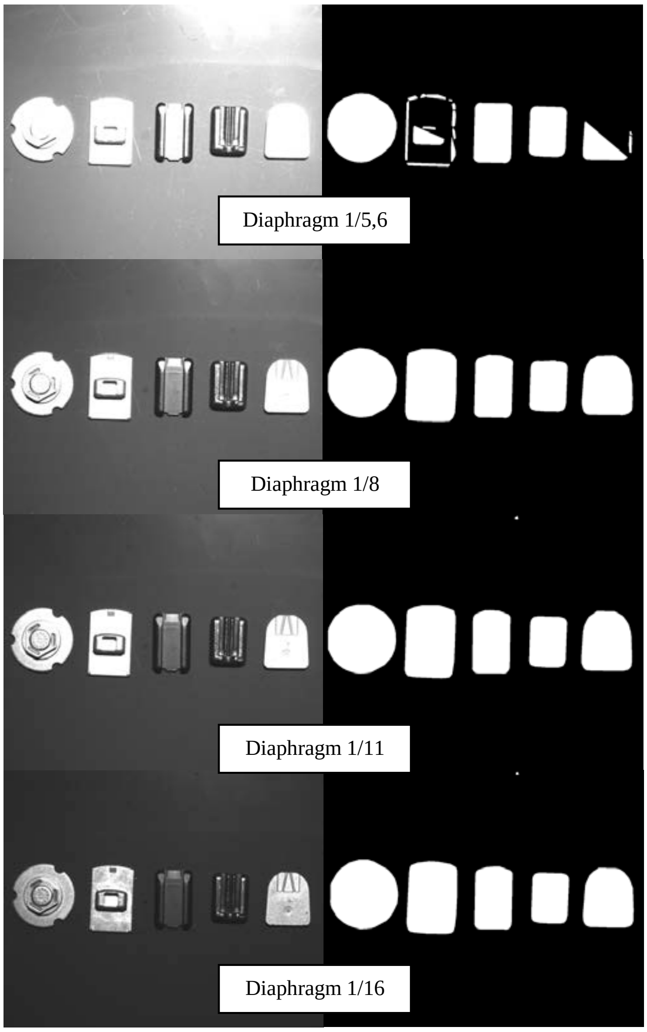

Fig. 4 *Images by HF25HA-1B, different diaphragms used*

As we can see identification was successful in a range of diaphragm 1/8 - 1/16. Imperceptible fault is possible to see on last two images (that means by diaphragm 1/11 and 1/16). This tiny small white point was caused by objective dustiness. That can be of course cleared away manually, but for this measurement it was let there on purpose to real production process simulation. Script was incrementally improved to eliminate these false objects.

5. CONCLUSION

The aim of this work was to verify a possibility of holder scanning and to reliably determine their location. According to this experiment recommended adjustment of each component together with the script for the future position determination by an industrial camera was set. Accuracy of this localization was set to 0,82 mm.

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