DEVICE FOR DETECTIONS SMALL OBJECTS

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Abstract: This article is about device for detection small object. Article describes construction device and software solution for detection small objects in image. Hardware construction of devices consists of Ethernet camera, telecentric objective, lights and variable holders. Software solution consists of camera communication driver and algorithm for detection and classification objects. This device will be used in laboratory Computer vision.

Keywords: Hough transform, OCR, Radon transform.

1. INTRODUCTION

Detection of small objects is a specific case. Surface of material covers a many typical features and if we wish detect small object, then our approach must be different. Typical surface may be a abrasions, cragginess, foreign objects or other problems. For these problems we must construct a specific program for detections small object.

Small objects, in this project, are representation by microdots in this case. Microdots are objects with dimension about 0.5 mm and with specific shape. Shapes of the microdots are consisting for eight lines and microdots have shape of octagon. This shape is good for many methods of identification. In this case is using detection by Hough transformation. Hough transformation detection of lines in image and these lines are easy to check interacts between them.

2. CONSTRUCTION OF DEVICE

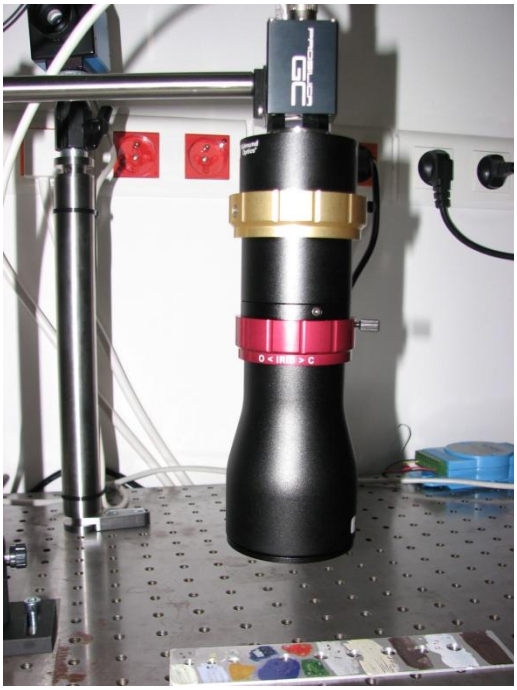
2.1. HARDWARE PART

A hardware part is guaranteed of scanning image, transfer data from camera to PC, lightening and holding camera and lightening. Most difficult task was design scanning chain, because holder of camera isn't in fix position. Vibration of holder may cause defocusing of scanning image. For this reason is good to use objective with big depth of field. From many possible objectives was select objective Gold Series Focusable Telecentric by Edmund Optics. Depth of field of this objective is ± 1 mm at F10. Objective has variation focal length and working distance is 98 – 123 mm.

For scanning image is using Ethernet camera Prosilica GC 1290. Prosilica GC 1290 is mono color camera with CCD sensor. Camera resolution is 1280x960 pixels and 32 fps at this resolution.

2.2. COMMUNICATION WITH CAMERA

Communication with camera is through the Ethernet. Every camera has an IP address and it is possible connects more camera to same network. Data transfer is asynchronous. This attribute brings some specific. In program must be few waiting command or cycles. Communication program was created in language C++, but company Allied Vision has driver support for Matlab. Program, which was created in C++, is much faster than program created in Matlab.



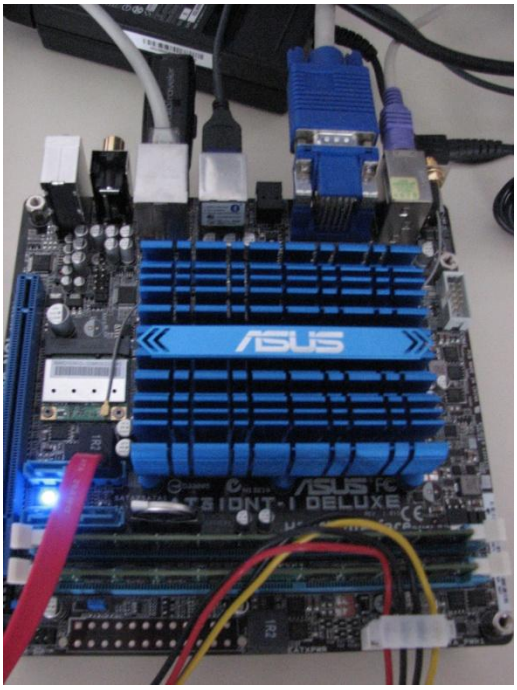


Image 2.1 Scanning device

2.3. LIGHTENING

For better quality of image is necessary use extern light. Scene with addition lights has much more details than scene without lights. But mainly advantages lighting is setting of depth of field and setting short time of exposition.

Depth of field is important because makes an images more resistance on a vibration and moving of camera on surface. Depth of field (DOF) is directly depends on lightening. Depending on lightening shows next formula:

$$DOF = \frac{2 \cdot N \cdot c \cdot f^2 \cdot s^2}{f^4 - N^2 \cdot c^2 \cdot s^2} \qquad [2.1]$$

When is: ***c*** is circle of focus, ***N*** is iris number, ***s*** is distance of object and ***f*** is focus length.

Value of lightening isn't direct in formula, but iris number (N) depends on lightening. We may simple say: "higher lightening is higher iris number". From the formula (2.1) follows, that high level of iris number means high value of depth of field.

Wavelength of lightening isn't too important because camera is only mono color. But in some specific case is good to use light with narrow wavelength. On surface microdots is hologram. This hologram is responsive on some wavelength and shows specific part on the object. This specific part may simplify detection search small object.

2.4. DETECTION

Detection is depending on character of detection object. This article describes detection of microdots and principle of detection. Detection of microdots use detection founded of shape. Microdots have octagon shape. Every side is line and for detection line in image is good use Hough Transformation (2.2). But in image may be more lines then lines from microdot. We must check lines position for correctly detection of microdot. Relationship between lines describes their angles. Procedure of detection is very simple.

$$x \cos\theta + y \cos\theta = r \quad [2.2]$$

When: x is length normal from line to starting coordinates, θ is angle between normal and axis x.

In the first step we use edge detector on image. This binary image contains border of all object in image. Next step is use Hough transformation on binary image. Hough transformation transfers linear coordinate to polar coordinate. Product of previous operation is accumulator with lines. Third step is searching relationship between lines. Select line with maximum value in accumulator and check relationship with other lines in accumulator. If is angle of checked line in set of angles, then this line will be marked. This step repeats until we searched all lines of the octagon. Fourth step select founded microdots for next image processing.

Image 2.2 Detection of microdot

2.5. DETECTION OF TEXT ON MICRODOT

After localization microdot is necessary localize text on microdot. Text on microdot is in fixed position, but for correct detection text is necessary rotate microdot to correct position. Every line in accumulator is describes by angle and position from reference point. We may take any line of border of microdot and rotate all microdot by angle of line.

Now we have microdot in horizontal position, but text in microdot may be in wrong position. For example show image 2.3. For rotate text to correct position is good using horizontal projection. Projection creates function. From this function we may compute mean and median value. After computation we are rotate microdot by 45° and compute mean and median. Check text position we must repeat this process fourtimes by 45°. Now we have four mean and median. Medians values in all rotating case are stay same, but means values will be different. The highest difference of mean and median specifies correct text position. Values of differences are show in image 2.3

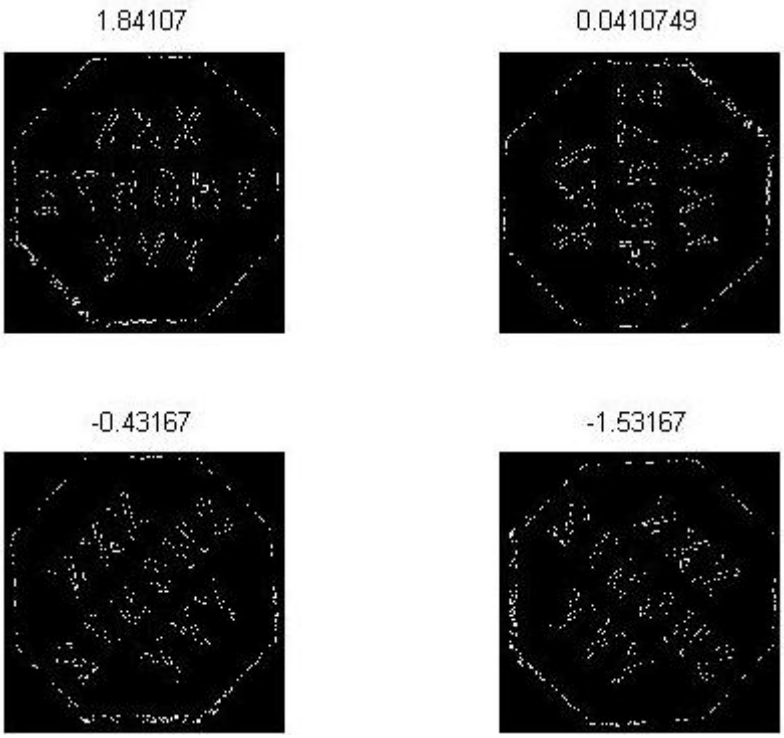


Image 2.3

2.6. RECOGNITION OF CHARACTERS

After localization text on microdot is necessary segmentation characters from text. Characters are in three lines. Detection of line position is good using vertical projection to axes x. Projection has three maximum. Every maximum corresponds with line in same position. We cut all text to lines now. Segment characters from line is using projection to axis y. Shape of projection specify number of character, because maximum correspond character position.

Classifications of characters aren't easy problem. Character may be in four positions. Classification method must recognize character in all positions. Positions may be in right position, character may be mirroring, rotating about 180° or combination rotating and mirroring.

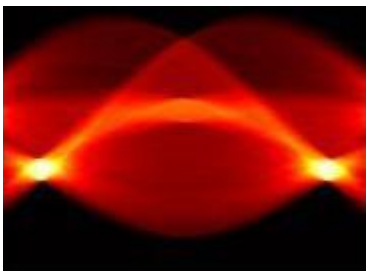


Image 2.4 Sinograph of character "A"

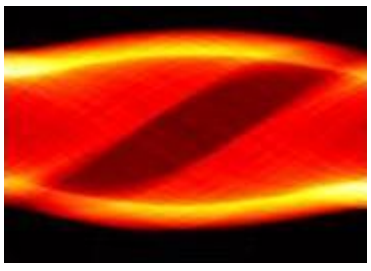


Image 2.5 Sinograph of character "C"

Radon transformation is transforming from linear coordinate to semi-polar coordinate. Product of Radon transformation is sinograph. Every character has unique shape in sinograph (image 2.4 and 2.5). All sinograph of characters compare with ideal sinograph. This method of classification is independents on character mirroring and rotating. Shape of character in sinograph is only shifted in axis x for rotating characters and inversed in axis y for mirroring.

3. CONCLUSION

In this article was describes device for detection of small object. Device will be using in laboratory for learning students. Students will have good opportunity for learn specific problems in computer vision.

This device is consisting from two parts. First part is hardware and second is software. Hardware part is almost complete, but software part is in developing now. Algorithm for classification is staying testing and some algorithm was developed in program Matlab. Matlab algorithm will be transfer to language C/C++.

Classification by Radon transform is in research, because this method has good potential for robust classification and noise tolerant. Radon transform give a good results for damage of character. This problem is in research too.

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