システムデザイン研究科　機械システム工学域　博士前期課程　公開期末評価　(2018/8/6)

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Evolutionary Robot Vision for Target Detection with Unclear Shape in Fiber Images

Background

In the fiber connection process, the cross section of the two fibers can be observed by the camera. Robot vision can be used to perform target detection on the fiber cross-section to adjust the position and align the center of the two fibers.

Problems

In practice, the fiber center is not at the center of alignment and the focus is not properly adjusted. Therefore, there are mainly two problem to be solved. (1) detecting the target shape when in unclear state. (2) Computing the corresponding focus value.

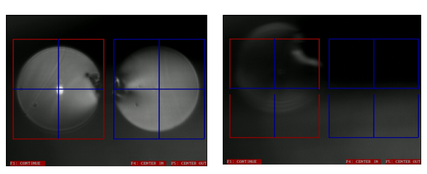
Objectives

In order to complete the fiber connection work more efficiently, it can be automatedly processed by using Robot vision for the above two cases. Therefore, The camera automatically recognizes the fiber target in different situation and adjusts the focus value.

Contents

target

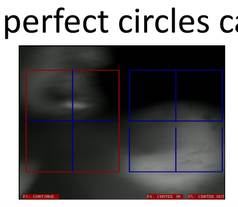
(1) Vulnerable to the environment, such as lighting changes, occlusion and background noise will have a greater impact on detection



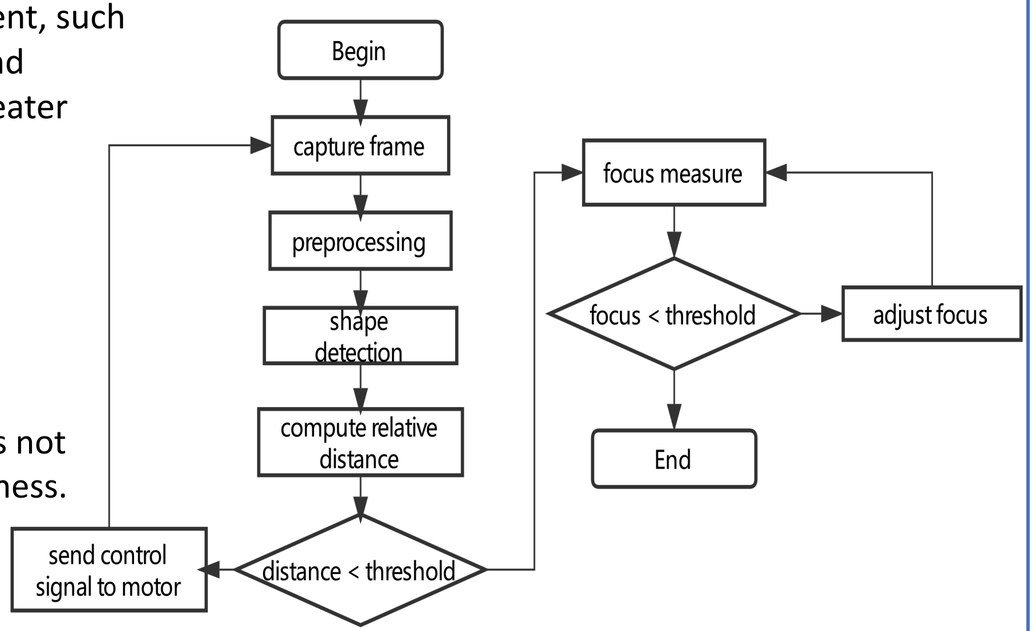
normal

lighting change

(2) The video frame sometimes is not a perfect circles caused by blurriness.



Pipeline



Focus Measure

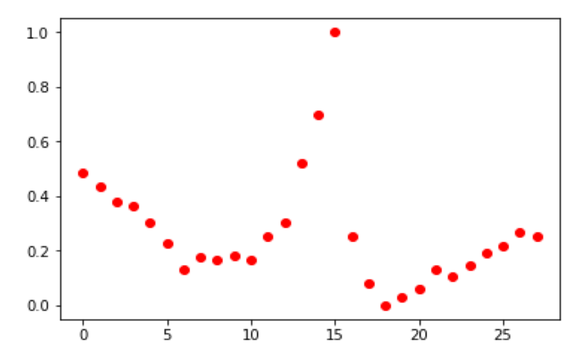
We compute focus measure based on the magnitude of image gradient:

$$\phi x, y = \sum_{(i,j)\in\Omega(x,y)} (Gx(i,j)^2 + Gy(i,j)^2)$$

where G_x and G_y are the X and Y image gradients computed by convolving the given image I with the Sobel operators.

then, normalize focus value

$$x^* = \frac{x-min}{max-min}$$



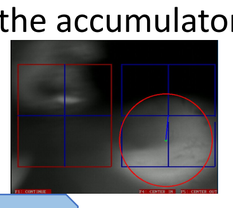
The change of focus value in a video stream.

Unclear Shape detection

Hough transform

Circle can be expressed as $r2=(x-a)^2+(y-b)^2$ in the parameter space. Therefore, $\rho=(a,b,r)$.
algorithm:

1. Initialize each A[a,b,r] = 0;
2. Preprocessing images and get edge images;
3. Vote all possible circles in the accumulator.
4. The local maximum voting circle of accumulator A gives the round Hough space.
5. The maximum voting circle of the accumulator gives the circle.

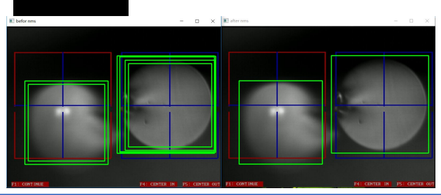


Shape based matching

The key of shape based matching is using gradient orientation. Once we have as many edges as possible if we want to find all the target shapes, we can use NMS to decrease the number and get a best shape left.

Step:
1.Create template
2.Template matching
3.Non-maximum suppression(NMS)

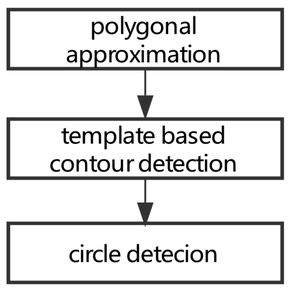
Circle template



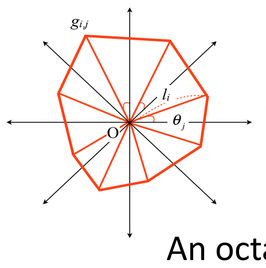
Steady-state genetic algorithm

Considering that in the fiber image the circle is not always perfect and can be polygonal, so we use SSGA based on template matching to detect contour.

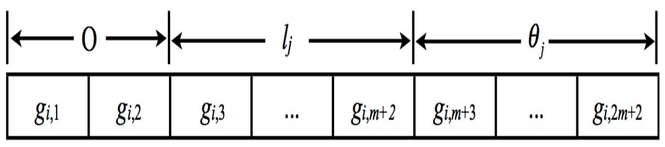
Steps:



(1) gray scale conversion from the color image by YUV model
(2) simple color extraction
(3) Using SSGA based on template matching for extracting a shape from the background image.



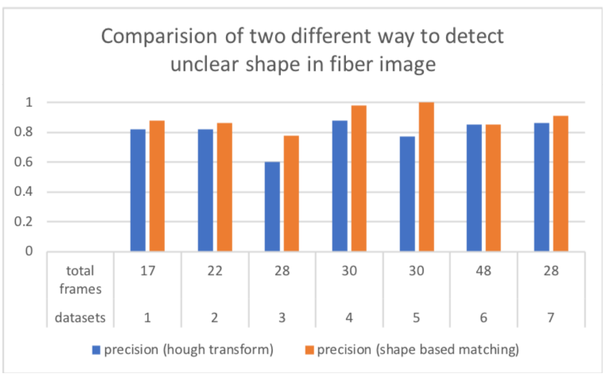
An octagonal template



Genotype in SSGA

Experiment

We make a experiment on 7 videos to separately compute its successfully detection rate(). Comparing the way of hough transform and shape based matching, we can get results as follows.



Detection method	Datasets	Average Precision
Hough transform	7 videos	80.0%
shape based matching	7 videos	89.4%

Conclusions

1. For unclear situations, shape based matching can significantly improve the successful detection rate.
2. For different videos, the stability of the detection circle is better.

Future work

・Object detection based on deep learning on iOS platform in next term.
・Acquire object coordinates using its 3D information.
・ Using iPhone to remotely control robot to grasp items.
・Establishment of environment for actual machine experiment.
・Experiment by actual machine.

Research Plan