

Report for Homework 4: Find the Gears

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1. Introduction

This work is about finding gears in the given image. The image contains several different shapes, including gears, circles, squares and so on. We are aiming to find the objects with gear shape.

2. Implementation

Fast Fourier Transformation is used in this assignment.

- 1) Preprocessing is necessary. We use close to eliminate small holes, and then get the boundary of all the shapes by subtracting original image from its dilation version. Of course, some other methods can also be used for obtaining the boundary.
- 2) Use command “bwlabel” to get the objects one-by-one. To eliminate noisy points or unnecessary small objects, we only consider objects whose number of foreground pixels is large enough (here more than 100).
- 3) For each object, use “bwtraceboundary” to get the boundary pixels, and compute the distances between the center and these pixels. Save these distances in a vector.
- 4) Use “fft” to get the coefficients, normalizing them.
- 5) Check the energy spectrum of the coefficients. If the spectrum has two peaks, we consider it generated by a gear shape.
- 6) Display the results. Numbers of teeth are shown in MATLAB command window.

3. Comments and problems

- 1) During the experiments I found, for every object, there are always big values in very low and high frequency, which make the number of peaks more than 2. I guess maybe it is because the objects to some extent have regular shapes in general (long period, low frequency), but much jitter in detail (high frequency). They are not very wired things. The solution is, I do not consider too low or too high frequency after fft for every object. Just give a threshold, a percentage to constrain the range. The comments in the code explain how I did.
- 2) To check the peaks, a simple way is to define a threshold. Any place where the spectrum value is larger than the threshold is considered as a peak. Although it is simple, I do believe it works. First, we have eliminated unnecessary peaks using method in the last step. Second, the peak value is usually much larger than others (the others are almost 0), therefore, it is very easy to define such a threshold.
- 3) Teeth number of the second one is correct. This gear object is perfectly described. But teeth number of the first one is perhaps incorrect (actually I don't know how many teeth on this gear). This is because the shape has too much noise in the left half and the boundary is not accurate enough, even if we preprocess it.

4. Conclusion

- 1) FFT is used for shape recognition.
- 2) The results are good, with minor reservation (the number of teeth).
- 3) We can use some other methods for boundary detection. For example, original image minus its erode version, and even non-morphological processing.