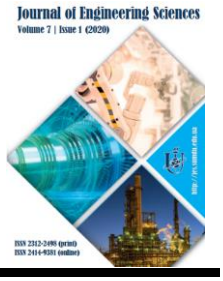
JOURNAL OF ENGINEERING SCIENCES

Volume 7, Issue 1 (2020)

Bonello, D. K., Iano, Y., Neto, U. B. (2020). An algorithm for the detection of circular elements in engineering design. Journal of Engineering Sciences, Vol. 7(1), pp. E6–E9, doi: 10.21272/jes.2020.7(1).e2



An Algorithm for the Detection of Circular Elements in Engineering Design

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Article info:
Paper received: December 22, 2019
The final version of the paper received: March 23, 2020
Paper accepted online: April 6, 2020

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Abstract. Various concentrated works have been done in the area of computational vision regarding the circle and texture detections. Detection of circles in images can be beneficial for PCB components industries for the detection of capacitors in printed circuit boards, also for medicine in the detection of red cells, white blood cells, and leukocytes, and for applications which requires precision and assignments regarding the detection of circles in a digital image. In this work is utilized a benchmarking of images to detection circle boards of different radio values for the comparison with the work [1] of this article. The benchmarking of images is composed of five main images that are tested in the algorithm of detection of circles in MATLAB with different values of radio for each image. The results appoint an enhancement of 300 % concerning the algorithm proposed in work [1] showed in this article. In this work also would be plotted graphs concerning the accuracy of the new proposed algorithm with relation to the algorithm proposed in work [1], indicating better results concerning the GUI interfaces and capacity of detection circles.

Keywords: computer vision, pattern recognition, an algorithm of detection, circle detection, parameter identification.

1 Introduction

The project in question views the study and development of an algorithm that can detect circles to start a bench of images, being possible this identification due to the circle detection algorithm developed in MATLAB used in this project. Thus, the main aim of this article is to provide an effective automated algorithm for the inspection of mechanical parts, which can be implemented in the milling machinery in the industry.

Is highlighted the importance of this kind of algorithm to the industrial sectors, because those areas are always looking for new alternatives to detect parameters involving circular geometry and enhance the quality of your laboratory tests, having in the confection of that algorithm with a capacity of detection of circular geometry (circular textures), an opportunity to found a low-cost implementation system that solves the most variable practical problems of detection circles for the PCB industries and industrial testing mechanical images.

The scheme described along with this scientific work, even being very easy to understand, allows the implementation of a serial of changes that are looking to adopt the algorithm of detection circles to the final user (industries or mechanical laboratories) objective with the finality of detection circular textures in images.

2 Literature Review

Old researches define the algorithm of circle detection as being essential for the detection of circular elements in mechanical parts.

One of the works related to the detection of circles is described in work [2] of that research, which cites the importance of developing algorithms able to detect circumferences. Hence that can be used in automatic inspection machines. Many other scientific works describe circle detection as an essential element of study: in [3] describes circle detection as an element of study capable of being a part of the machinery modeling for milling parts with precision and avoid defects in the process.

In work [3] is demonstrated that the big intelligent technologies are not possible only in huge types of machinery of large laboratories but also on a tiny scale to specific tasks.

According to various researches [4–11], the pattern recognition and identification engineering areas is one of the most affected with the autonomous identification systems, supplying perfection and more reliable identification techniques.

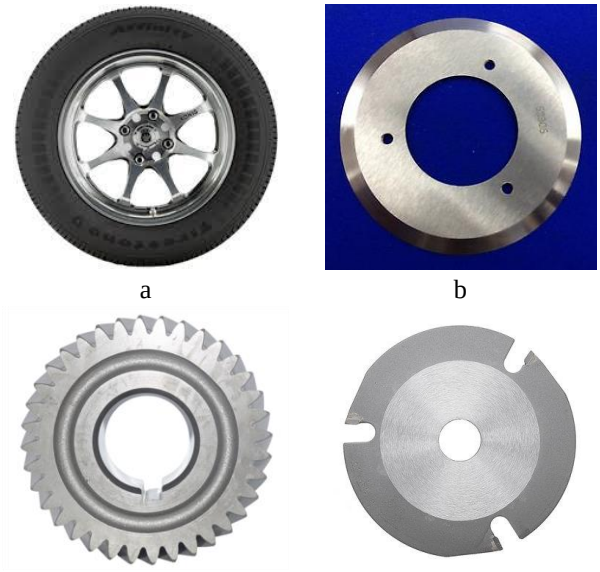
This project consists of going ahead systems as one of those authors that have innovated in the decade.

3 Research Methodology

3.1 Bench of images

A bench of 5 images was composed to test the algorithm of circle detection developed in MATLAB. There are images related to a bike, a car tire, a circular flange, a gear, and a blade.

Figure 1 indicates examples of circular elements in engineering design.



a b c d

Figure 1 – Examples of circular elements:
a – car tire; b – flange; c – gear; d – blade

3.2 Algorithm of circle detection developed using the MATLAB software

Figure 2 shows the screen of the algorithm developed in MATLAB for circle detection within a minimum ratio of 10 and the maximum ratio of 25.

3.3 The capacity of detection of the algorithm

The following Table 1 gives a summary of all quantities of circle detected in the algorithm for each image of the benchmarking of images.

Table 1 – Capacity of circle detection of the algorithm

The image description	Ratio	Quantity of circles
Car tire	10 ≤ R ≤ 25	08
Flange		01
Gear		05
Blade		01

```
% Button pushed function: CircledetectionButton
function CircledetectionButtonPushed(app, event)
    Img=evalin('base','Img');
    Img=im2bw(Img(:,:,3));
    Rmax=evalin('base','Rmax');
    Rmin=evalin('base','Rmin');
    disp('valoracao dos radios e inicio do processo')
    if or((Rmin<0),(Rmax<=0))
         Rmin=10;
         Rmax=25;
         f = msgbox('Algum dos valores e invalido, sera
    end
    if Rmax<Rmin
        %Rmin=10;
        Rmax=25;
        f = msgbox('O valor máximo e invalido, sera res
    end


    [centersDark, radiiDark] = imfindcircles(Img, [Rmin
                               'ObjectPolarity','brigh
    %imagesc(Img);
    %axes(app.UIAxes2);
    imshow(Img,'Parent',app.UIAxes2);
    %hold on
    tam=size(centersDark);
    taml=size(radiiDark);
```

Figure 2 – Algorithm of circle detection in MATLAB

3.4 Comparison with previous studies and improved algorithm GUI interface developed using MATLAB

Compared to the work [1] related in that article, we can see that the new algorithm proposed for detecting circles in MATLAB has an optimized interface with Rmin and Rmax buttons, set image, and set circle detection buttons as well implemented to him GUI interface (Figure 3).

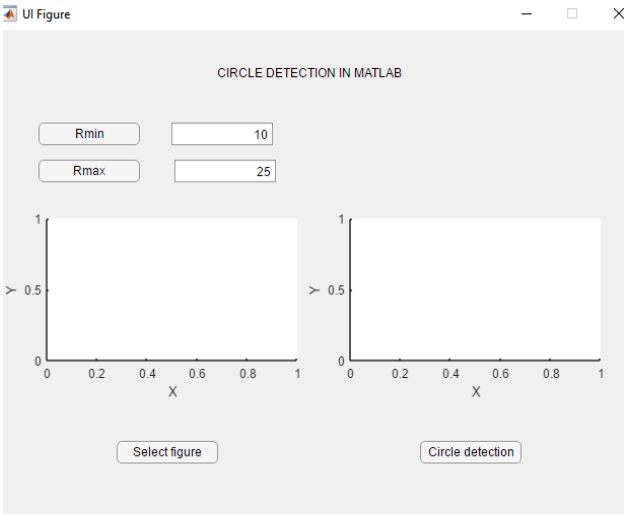


Figure 3 – Improved GUI interface of the algorithm

3.5 GUI interface of the images benchmarking for circle detection developed in MATLAB

Next is represented the GUI interface in MATLAB for circle detection of the images of Table 1 with the circles represented in the right frame (Figure 4).

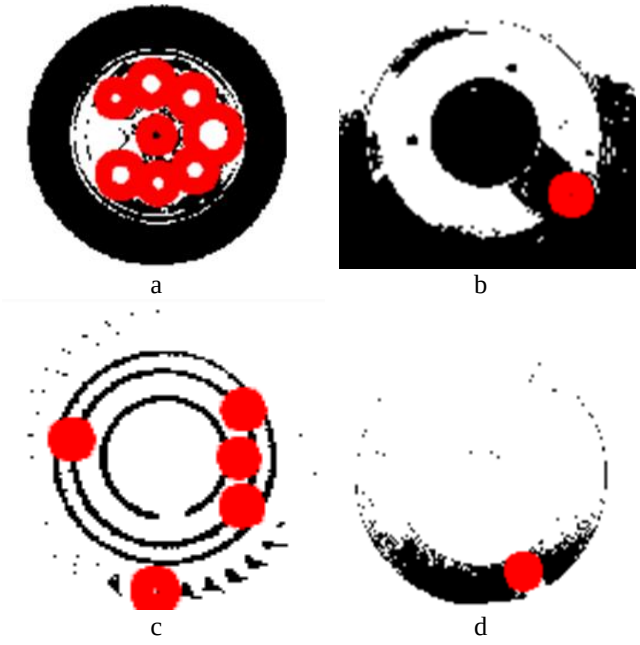


Figure 4 – Circle detection:
a – car tire; b – flange; c – gear; d – blade

4 Results and Discussion

The results appoint a maximum percentage growth of detection about 300 % in comparison to the previous algorithm used in work [1] related to that article. Figure 5 shows the detection capacity of the new algorithm concerning the number of circles detected by the previous algorithm.

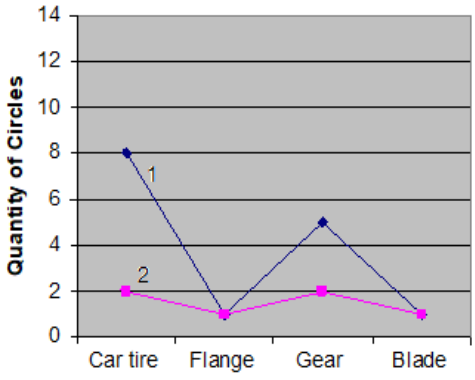


Figure 5 – Detection capacity:
1 – new algorithm; 2 – previous algorithm

Figure 6 shows the percentage growth regarding the number of circles detected when it is compared to the new algorithm and the previous algorithm.

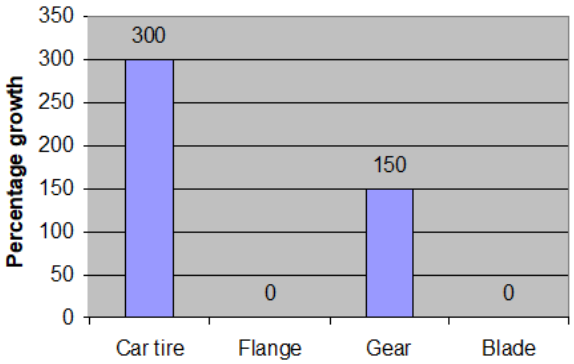


Figure 6 – Percentage growth of the new proposed algorithm

Those results show that circle detection for car tire image had the most percentage growth of circles detected, about 300 % more than compared to the previous algorithm implemented in work [1].

The main contribution of this work is related to the circle detection techniques using an algorithm developed in MATLAB to detect circular elements in mechanical parts. We believe that industries and mechanical process, such as the milling process, need for intelligent machinery to make the inspections tasks with precision and reliability. Therefore, with this vision in mind, an algorithm was developed capable of detecting circumferences in various mechanical parts with precision.

5 Conclusions

This work represents a contribution to the pattern detection (circle detection) of a benchmarking of images. Once defined, the new based algorithm and ratio detection in the figure, circular images were set to the edges detection (circles) with ratio selection dependents of the number of circles to be detected in the selected template. Was verified, the percentage of growth circle detection in the images of the benchmark in comparison to the work [1] related in this article, around 300 % better than the previous article.

6 Acknowledgments

The research was realized in the Laboratory of Communications at the University of Campinas.

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