

Geometric verification of External Spur Gears through Image Processing Techniques.

MDM19B006 - S.HARSHAVARDHAN REDDY

MDM19B007 - P.V.P.SAI NAMRUTH

MDM19B031 - JYOTI KUMARI

MDM19B034 - B.ANUPAMA SAI

Spur gears are a cylindrical shaped toothed component used in industrial equipment to transfer mechanical motion as well as control speed, power, and torque.

Industrial Applications of Spur gears are :

Transmissions, Speed reducers, Engines and mechanical transportation systems, Gear pumps and motors, Machining tools, Conveyor Systems etc.

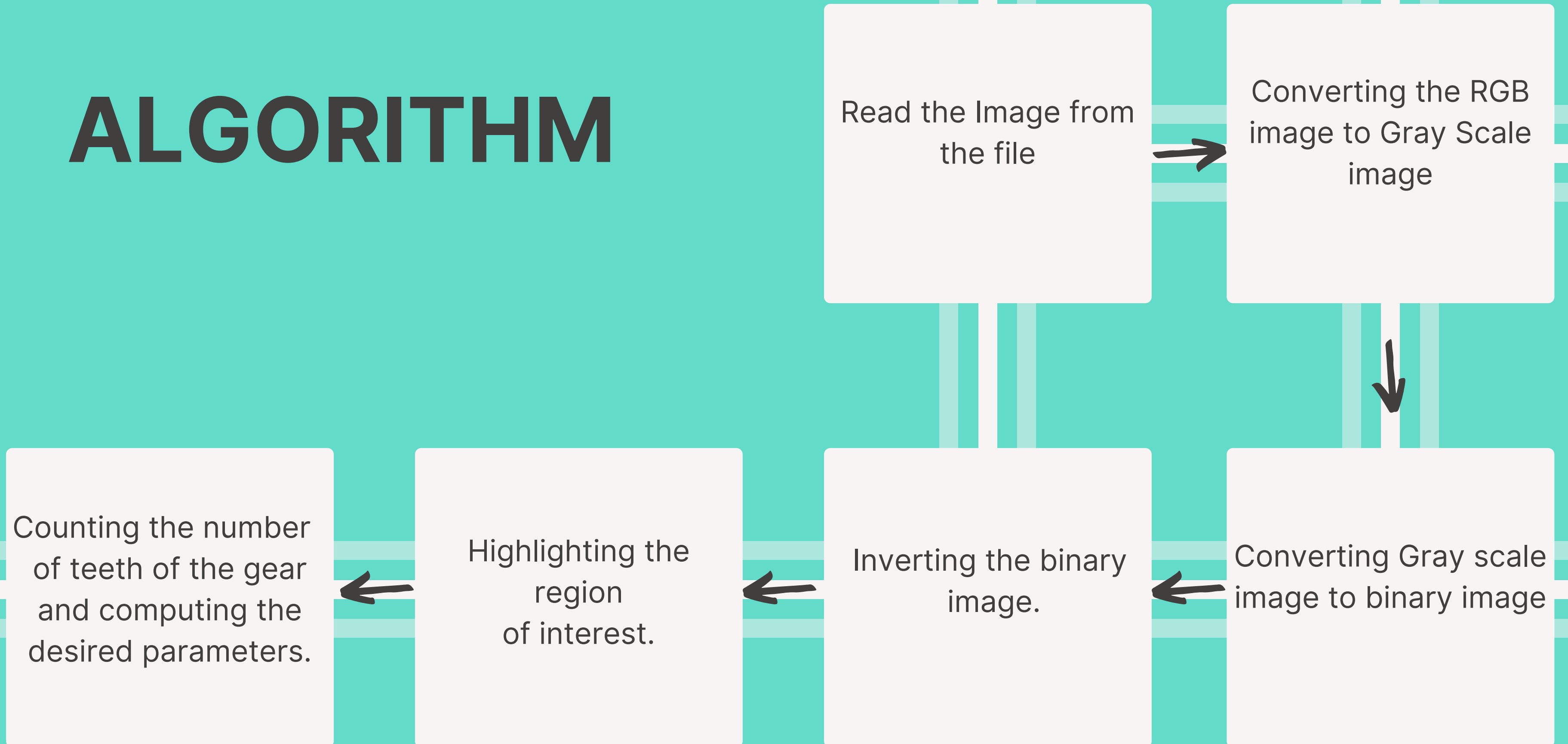
Advantages of spur gears are :

Simplicity, Constant speed drive, Reliability, Cost-Effectiveness, Efficiency, Simple Construction and installation.

Why do we need this technique for inspection of Spur gears?

Spur gears are manufactured in a large scale, and also products like these may need to be produced in large volumes for a customer. So the inspection of the gears is an important procedure for checking the overall quality of the manufactured gear, this will ensure that the parts are made to meet quality standards, as well as customer demands. As speed of the production should be fast, inspection process cannot be done manually, hence we can make use of this inspection technique to speed up the process and to improve the manufacturing process.

ALGORITHM



SOFTWARES USED:



MATLAB R2020b



Fusion 360

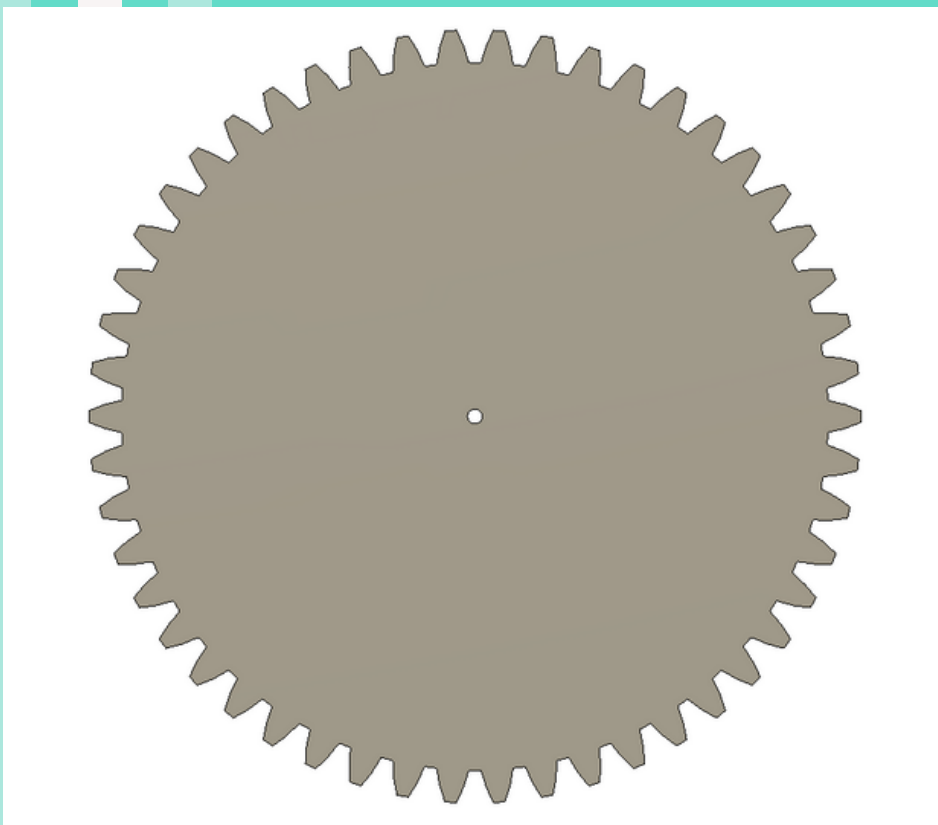
TO EXTRACT THE IMAGES OF NON DEFECTIVE AND
DEFECTIVE SPUR GEARS



Image Processing Toolbox

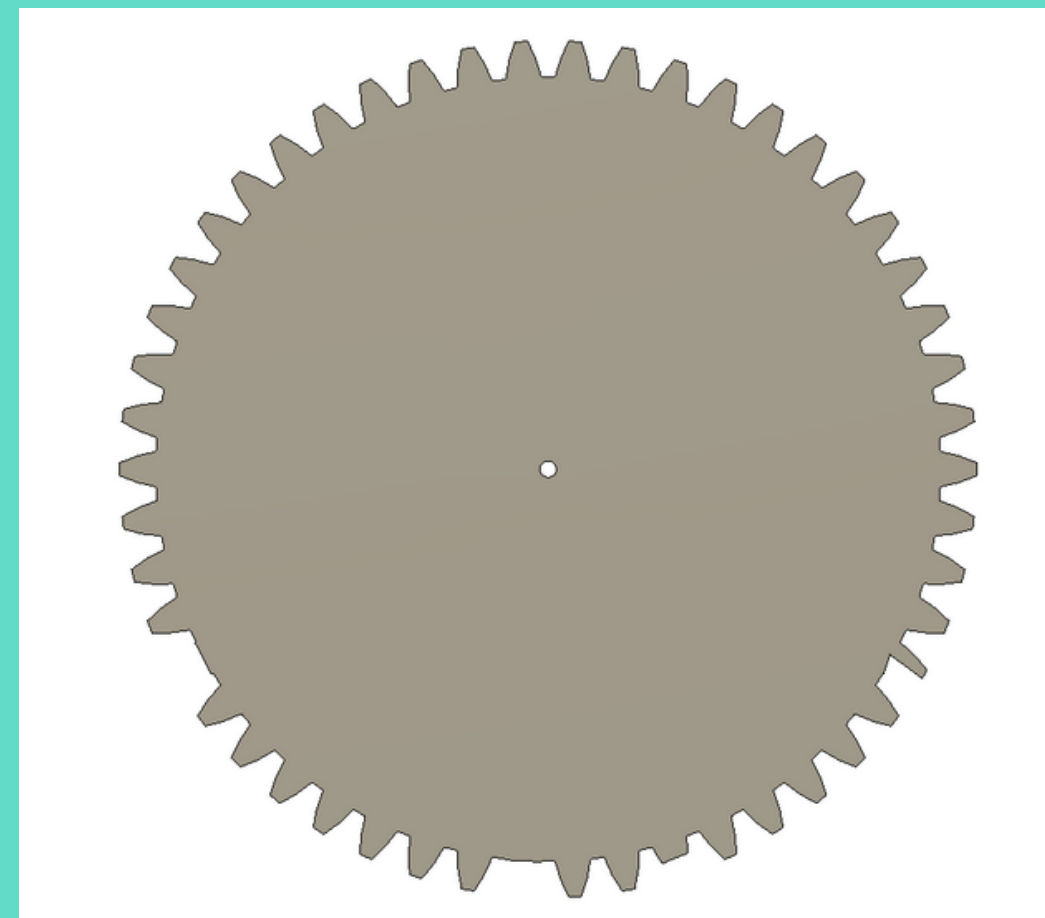
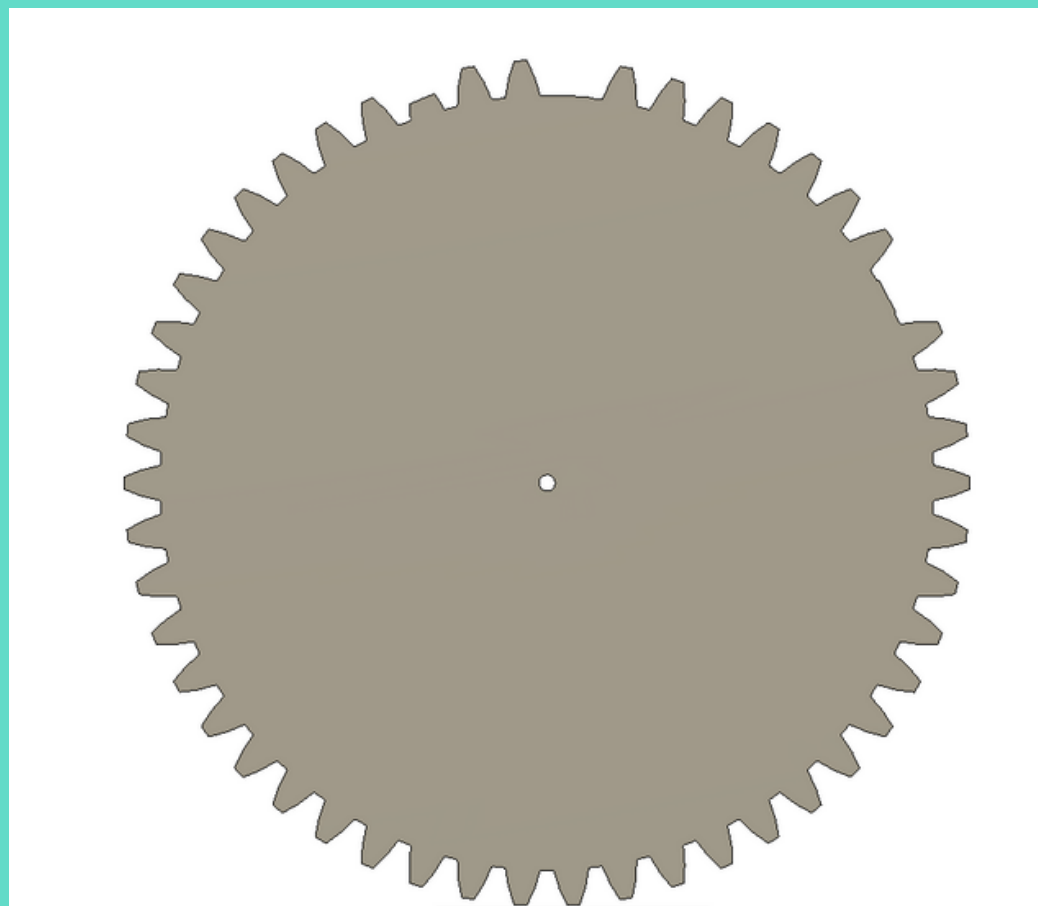


Images used:



NON-DEFECTIVE
SPUR GEAR

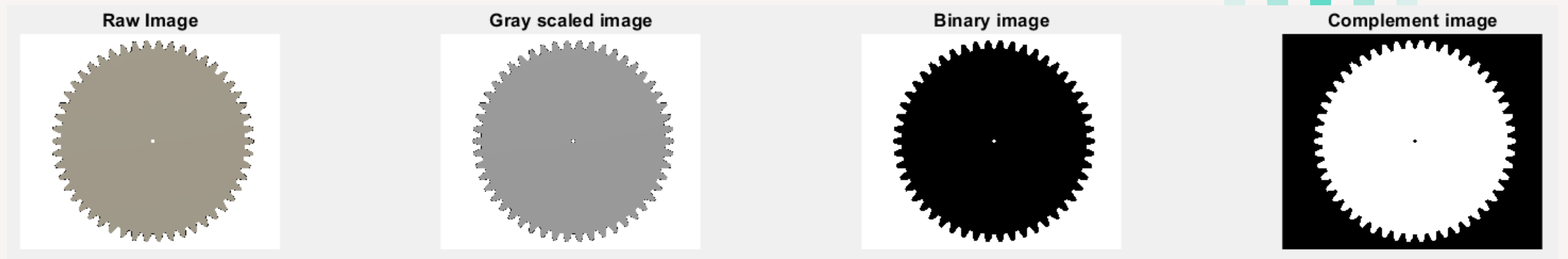
DEFECTIVE SPUR
GEARS



PIECE OF CODE :

```
1 - A = imread('spuring.jpeg');  
2 - fixednum = 50  
3 - B = rgb2gray(A);  
4 - C = imbinarize(B);  
5 - CC = imcomplement(C);  
6 - subplot(3,4,1); imshow(A) ; title('Raw Image')  
7 - subplot(3,4,2); imshow(B) ; title('Gray scaled image')  
8 - subplot(3,4,3); imshow(C) ; title('Binary image')  
9 - subplot(3,4,4); imshow(CC) ; title('Complement image')
```

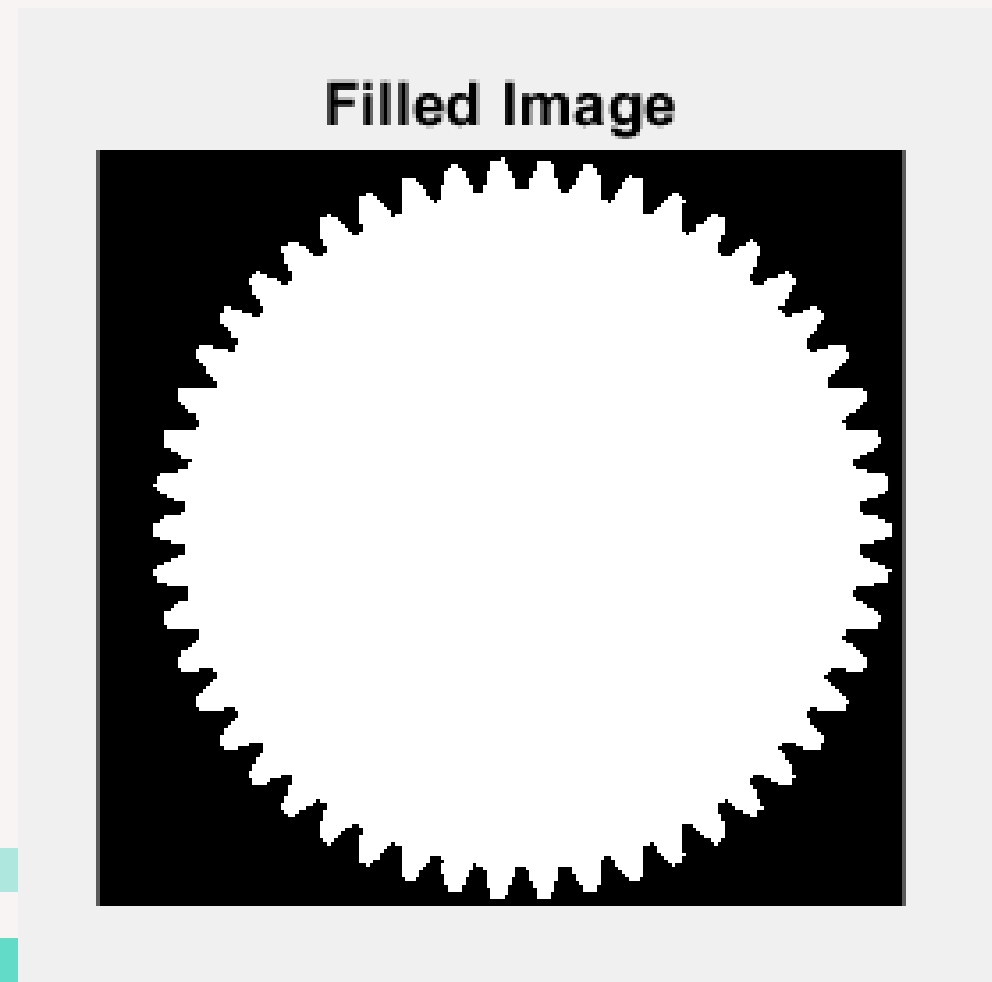
OUTPUT :



PIECE OF CODE :

```
11 %%Filling the holes
12 - CCF = imfill(CC, 'holes')
13 - subplot(3,4,5); imshow(CCF) ; title('Filled Image')
```

OUTPUT :



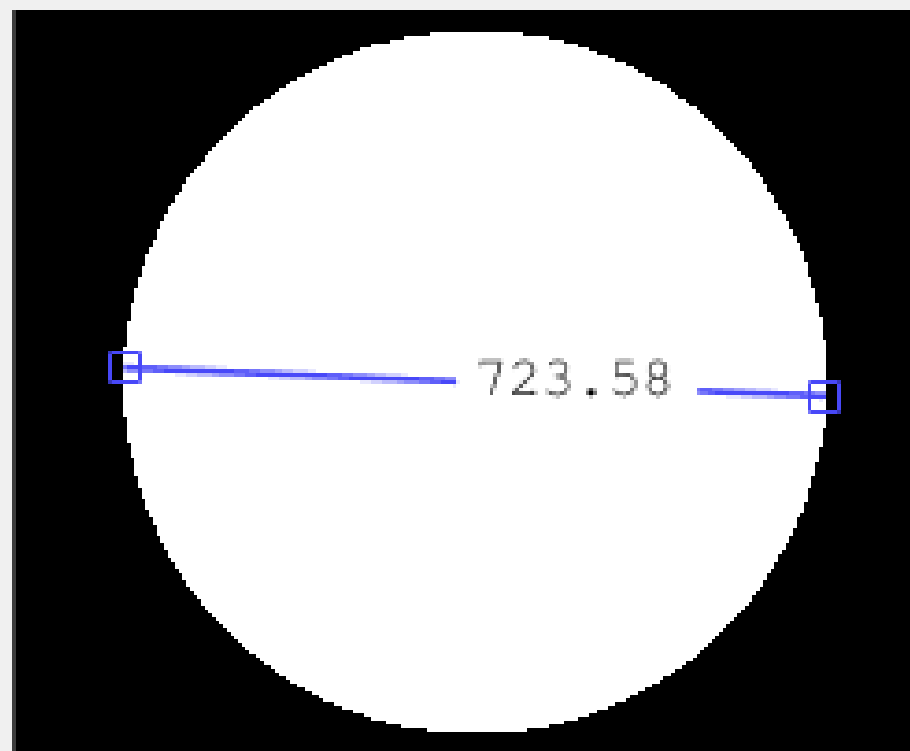
PIECE OF CODE :

```
15 %%Creating a Convex Hull Image, Addendum circle.
16 - CCH = bwconvhull(CC,'objects');
17 - [r,c]= size(CCH);
18 - [X1,X2,Y1,Y2]= distance(CCH,r,c)
19 - x=[X1,Y1];
20 - y=[X2,Y2];
21 - od=norm(x-y)
22 - subplot(3,4,6); imshow(CCH) ; hold on
23 - imdistline(gca,[X1,X2],[Y1,Y2])
24 - title('Convex Hull Image:Addendum circle dia');
```

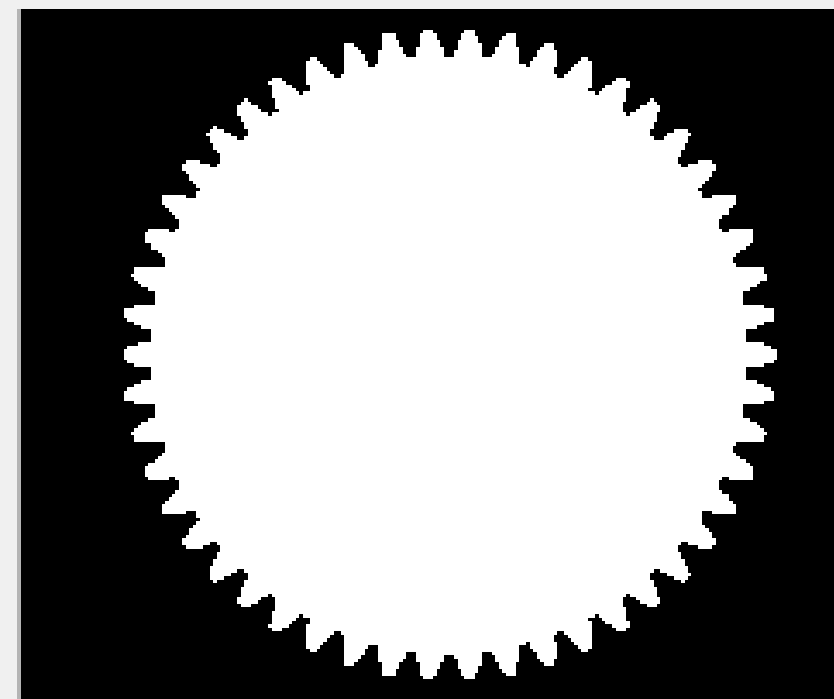
```
function [X1,X2,Y1,Y2] = distance(image,r,c)
    e1 = find(image~=0,1,'first')
    e2 = find(image~=0,1,'last')
    X1 = ceil(e1/r);
    X2 = ceil(e2/r);
    Y1 = rem(e1,r);
    Y2 = rem(e2,r);
end
```

OUTPUT :

Convex Hull Image:Addendum circle dia



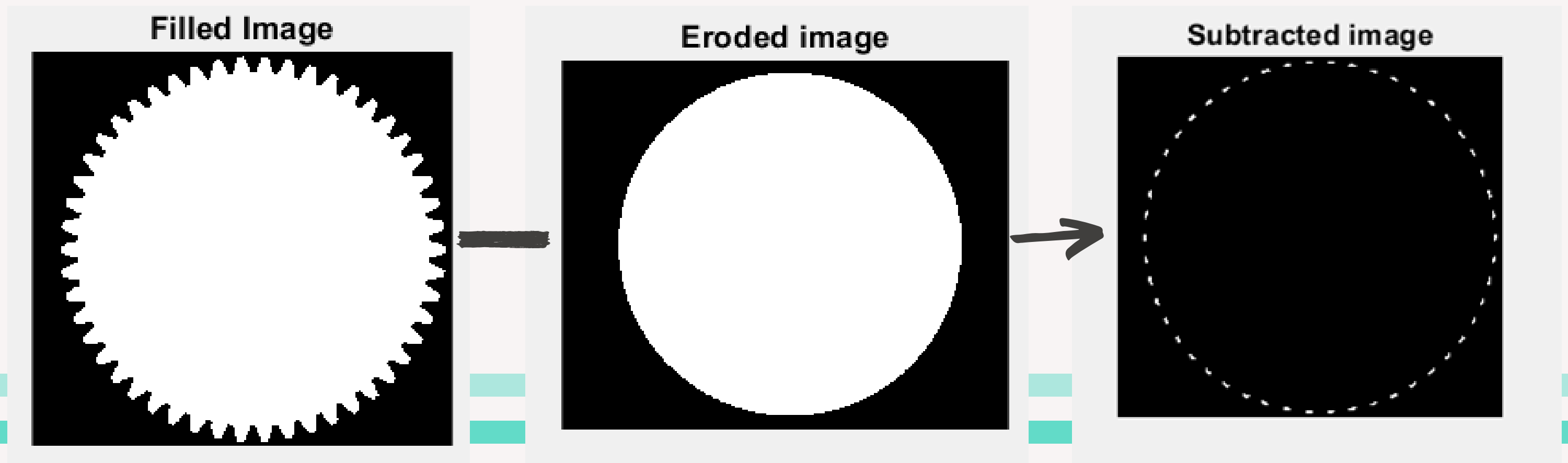
Filled Image



PIECE OF CODE :

```
32 %% Eroding the hull image with a disk lesser than 5 pixels
33 - CCM = imerode(CCH, strel('disk',5));
34 - CCT = imsubtract(CCF,CCM);
35 - CCL = im2bw(CCT);
36 - subplot(3,4,7); imshow(CCL) ; title('Subtracted image')
```

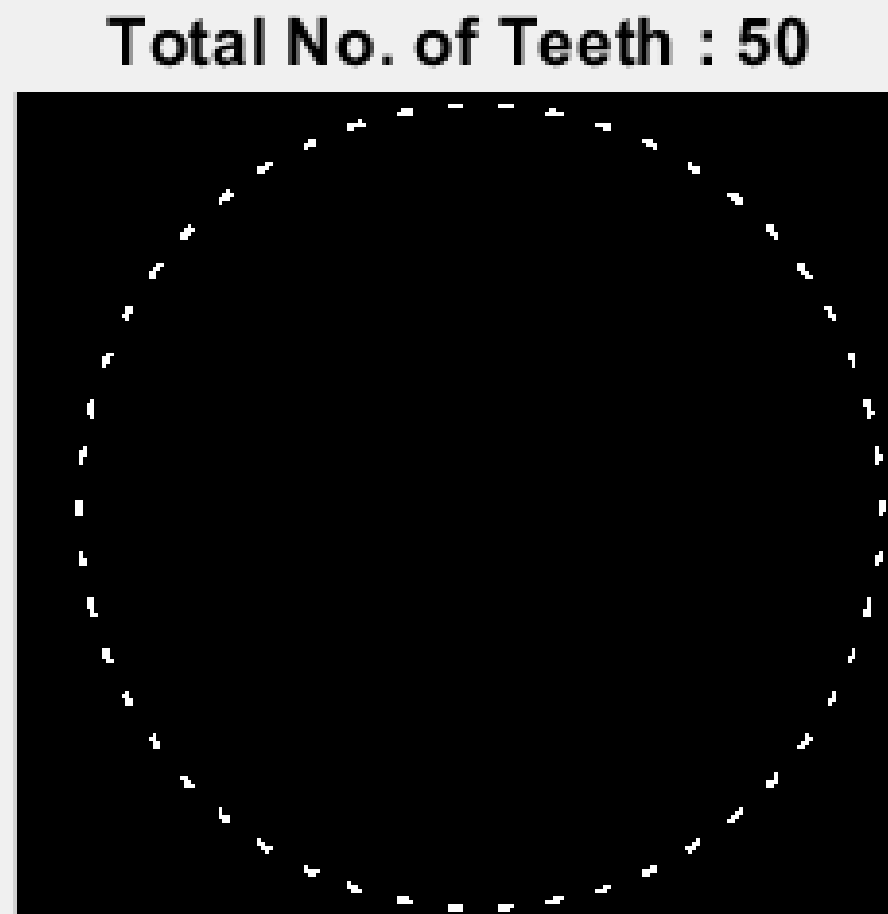
OUTPUT :



PIECE OF CODE :

```
38 %%Removing less than 48 pixel blocks
39 - CCA = bwareaopen(CCL,48);
40
41 - [L num]= bwlabel(CCA);
42 - subplot(3,4,8); imshow(CCA) ; title(['Total No. of Teeth : ',num2str(num)]);
43 - subplot(3,4,9); imshow(A) ; title(['Total No. of Teeth : ',num2str(num)]);
44 - if num == fixednum
45 -     text(0,0,'Passed','Color','green','FontSize',14);
46 - else
47 -     text(0,0,'Rejected','Color','red','FontSize',14);
48 - end
```

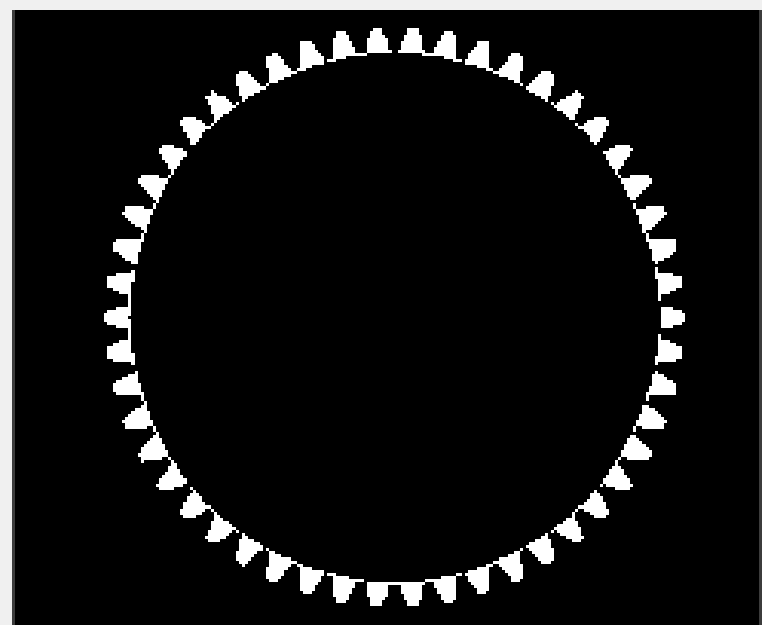
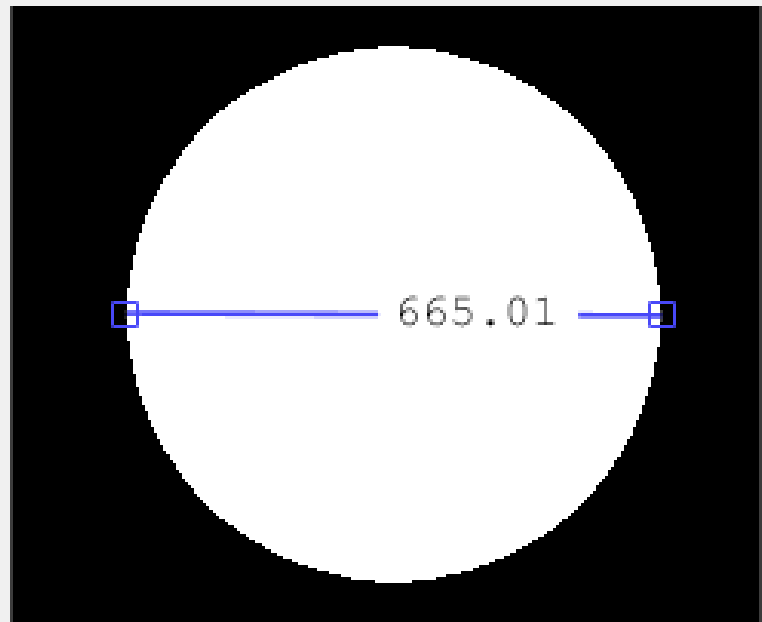
OUTPUT :



PIECE OF CODE :

OUTPUT :

Base Circle,Dedendum circle dia



```
50 %% Creating Dedendum circle, base circle .
51 - for x=5:100
52 -     CCM1 = imerode(CCH, strel('disk',x));
53 -     CCT1 = imsubtract(CCF,CCM1);
54 -     CCL1 = im2bw(CCT1);
55 -     CCA1 = bwareaopen(CCL1,8);
56 -     [L num1]= bwlabel(CCA1);
57 -     if num1 == 1;
58 -         break;
59 -     end
60 - end
61 - [s,t]= size(CCM1);
62 - [X3,X4,Y3,Y4]= distance(CCM1,s,t)
63 - p=[X3,Y3];
64 - q=[X4,Y4];
65 - id=norm(p-q)
66 - subplot(3,4,10); imshow(CCM1) ; hold on
67 - imdistline(gca,[X3,X4],[Y3,Y4])
68 - title('Base Circle,Dedendum circle dia');
```

PIECE OF CODE :

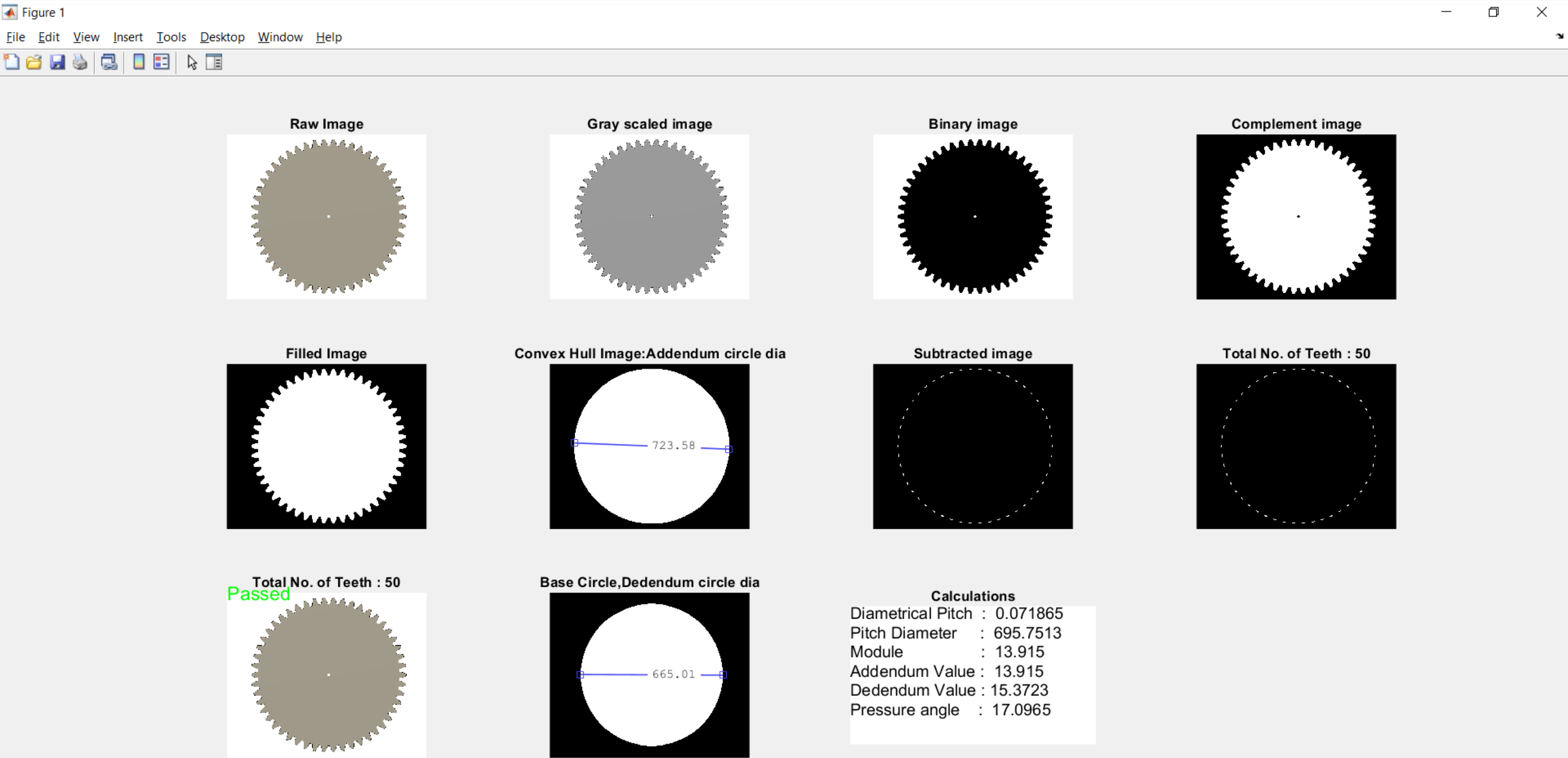
```
70 - Diametrical_pitch = (fixednum+2)/od
71 - Pitch_diameter = fixednum/Diametrical_pitch
72 - Addendum_value = (od-Pitch_diameter)/2
73 - Dedendum_value = (Pitch_diameter-id)/2
74 - Module = Pitch_diameter/fixednum
75 - Pressure_angle = acosd(id/Pitch_diameter)
76 - subplot(3,4,11); imshow('whitenew.png') ; title('Calculations');
77 - text(0,50,['Diametrical Pitch : ',num2str(Diametrical_pitch)],'Color','black','FontSize',12);
78 - text(0,200,['Pitch Diameter : ',num2str(Pitch_diameter)],'Color','black','FontSize',12);
79 - text(0,350,['Module : ',num2str(Module)],'Color','black','FontSize',12);
80 - text(0,500,['Addendum Value : ',num2str(Addendum_value)],'Color','black','FontSize',12);
81 - text(0,650,['Dedendum Value : ',num2str(Dedendum_value)],'Color','black','FontSize',12);
82 - text(0,800,['Pressure angle : ',num2str(Pressure_angle)],'Color','black','FontSize',12);
83
```

OUTPUT :

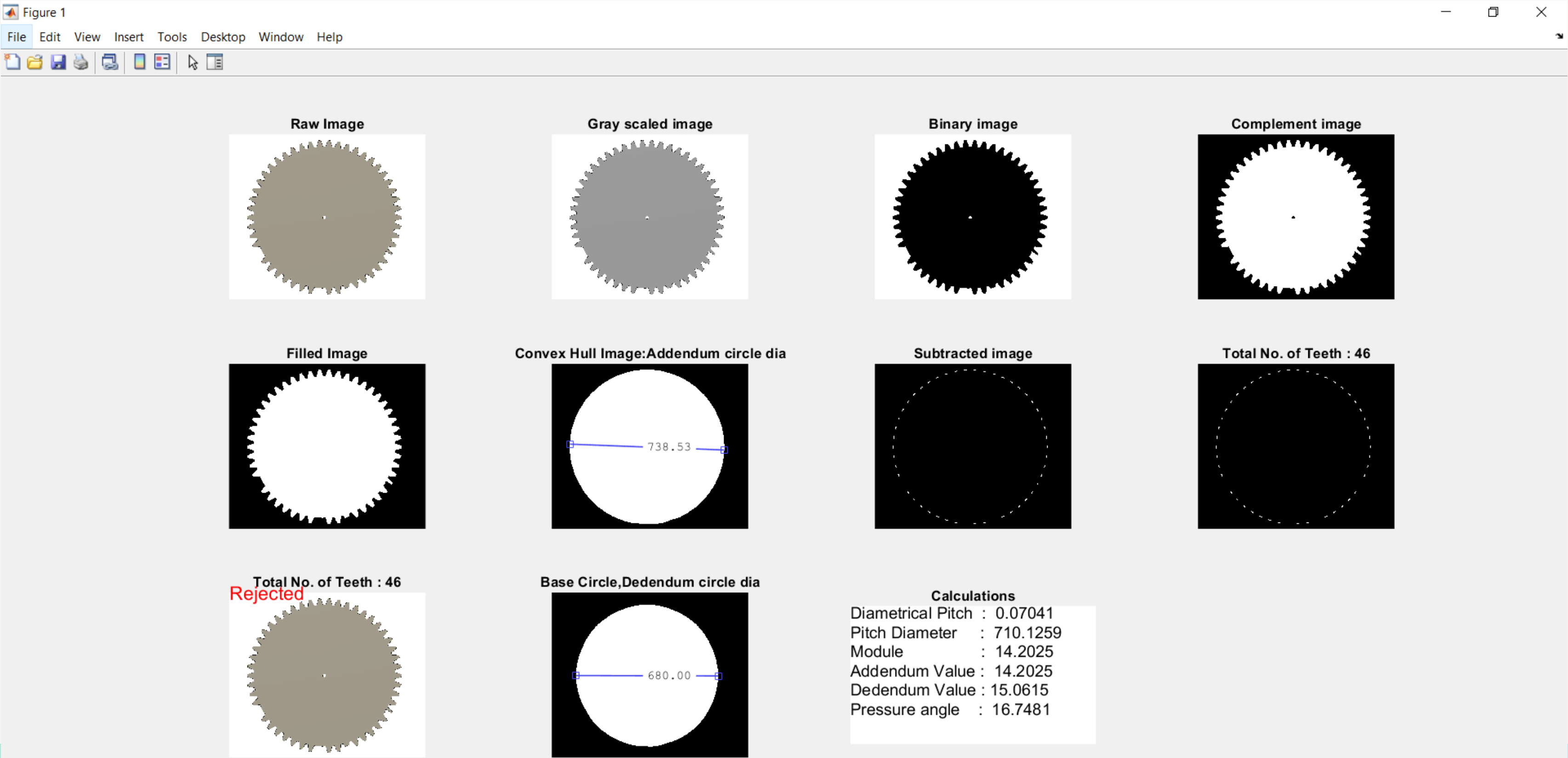
Calculations

Diametrical Pitch : 0.071865
Pitch Diameter : 695.7513
Module : 13.915
Addendum Value : 13.915
Dedendum Value : 15.3723
Pressure angle : 17.0965

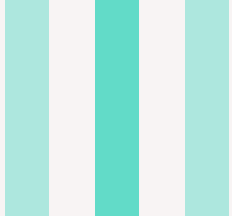
OUTPUT OF THE CODE FOR NON-DEFECTIVE SPUR GEAR :




OUTPUT OF THE CODE FOR DEFECTIVE SPUR GEAR :




REFERENCES:




<https://www.youtube.com/watch?v=7Y6leFWrZ9I>



https://www.researchgate.net/publication/275335648_Gear_Measurement_Using_Image_Processing_in_Matlab



https://drive.google.com/drive/folders/1LaOxXb9g8XYvpJX5X7d_MnnRly_JGHoJ?usp=sharing



Thank You