



# Quality Classification of Tortillas using Computer Vision

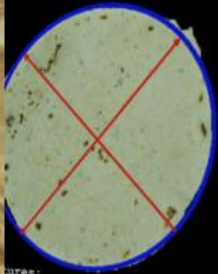
Domingo Mery, Jorge Chanona, Álvaro Soto,  
José Miguel Aguilera, Aldo Cipriano, Nayeli  
Vélez, Israel Arzate, Gustavo Gutiérrez

UNIVERSIDAD CATÓLICA DE CHILE

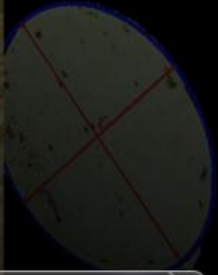
INSTITUTO POLITÉCNICO NACIONAL DE MÉXICO

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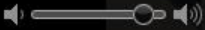
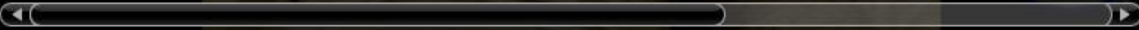
Supported by grant No. R0308LAC003 LACCIR



ures:  
7.02 cm  
6.58 cm  
0.9379  
0.3218  
6.28 cm  
1.05 cm  
ntea:



# 1 Introduction





## CONSUMER PANEL DATA SHEET

Gender: Female \_\_\_ Male \_\_\_ Age: \_\_\_\_

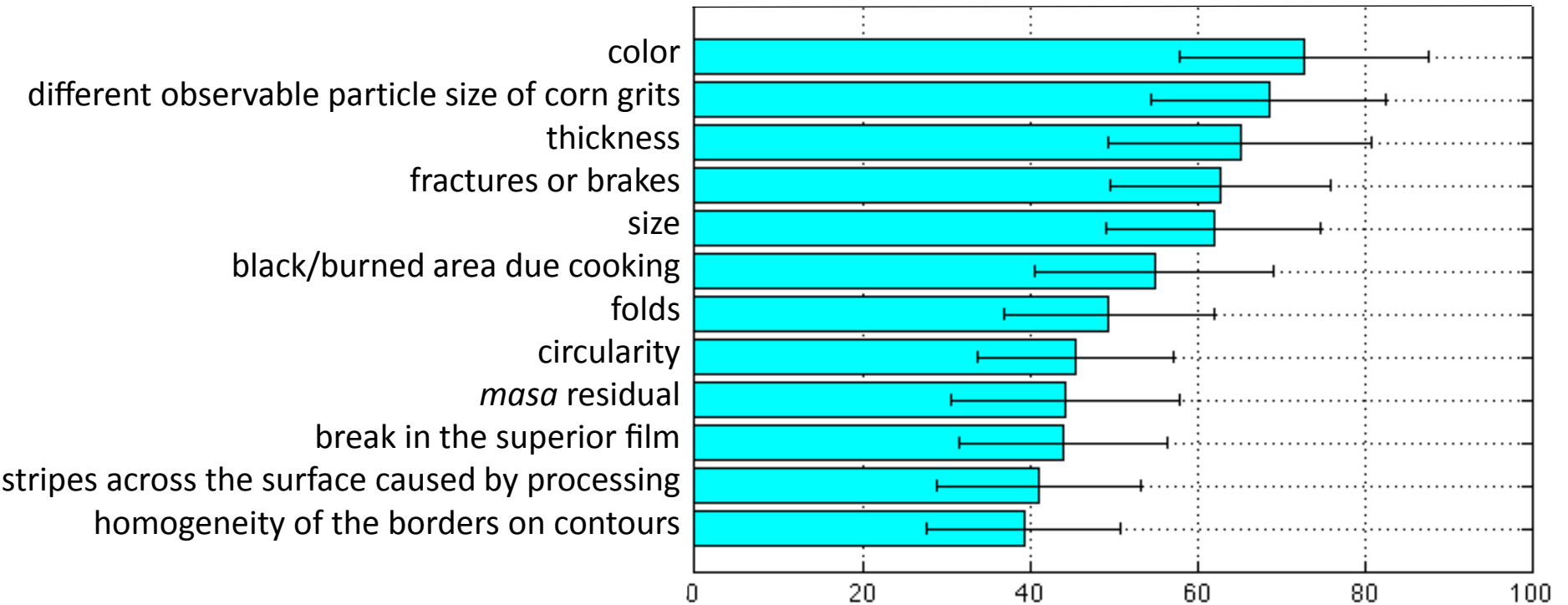
**INSTRUCTIONS:** Corn tortillas will be evaluated; please order the following quality tortilla attributes by importance to the consumer, being 1 the most important attribute and 12 the less important.

Color	
Size	
Stripes across the surface caused by processing equipment	
Different observable particle size of corn grits	
Black/burned area due to cooking	
Fractures or breaks	
Folds	
Circularity	
Thickness	
Breaks in the superior film	
"Masa" residuals	
Homogeneity of the borders or contours	

If you consider missing important attributes, please mention them:


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## Score of the visual attributes

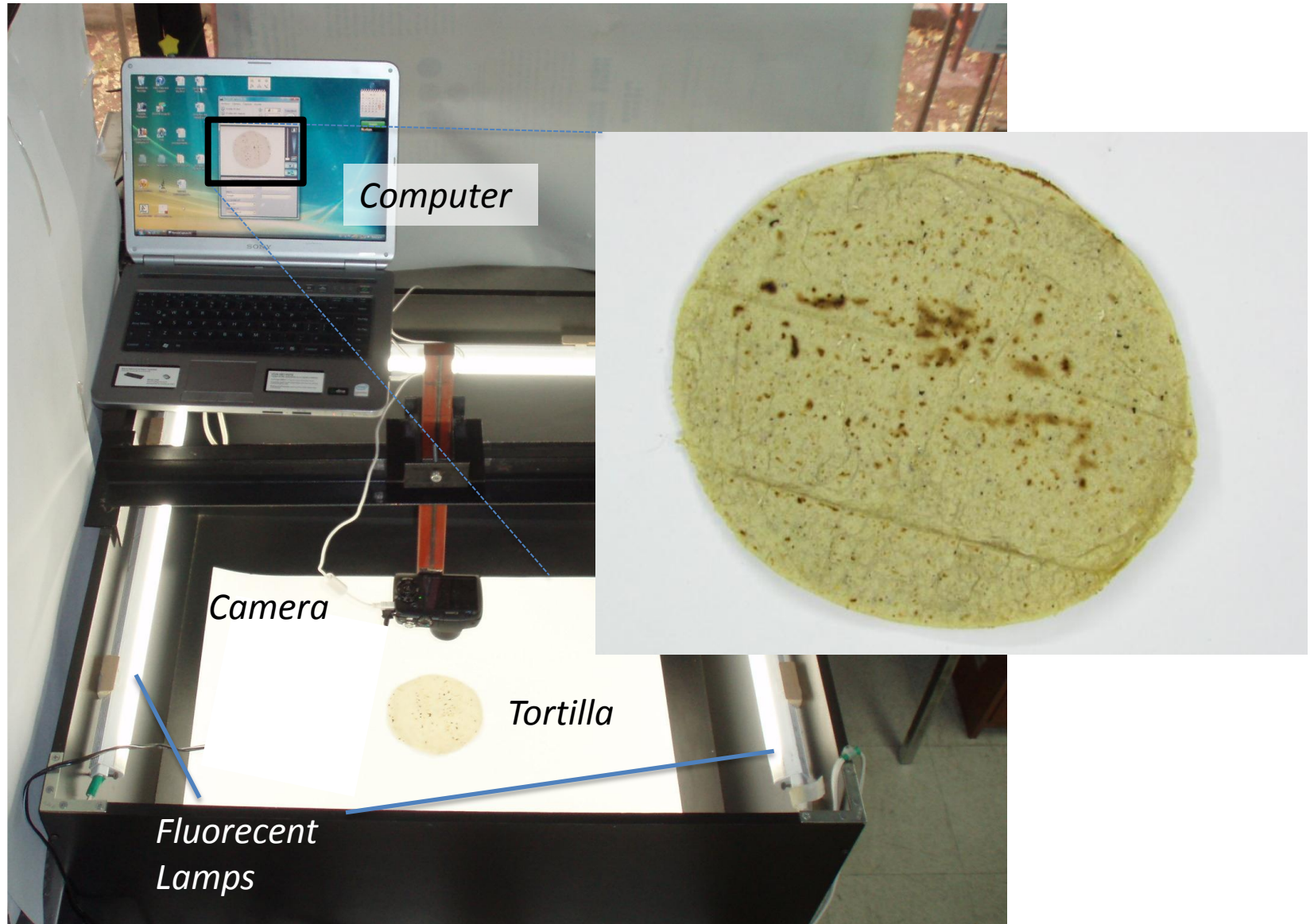


Hedonic scale or Sub-classes

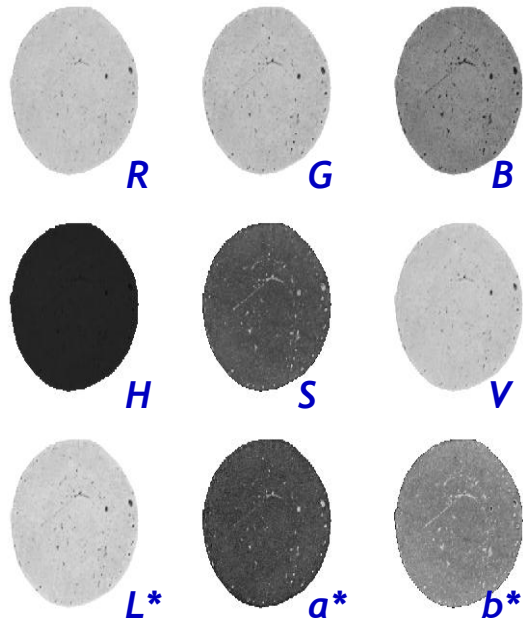
1	2	3	4	5
like extremely	like	neither dis-like nor like	dislike	dislike extremely

S small					
M medium					
L large					

# Computer Vision System



*Image acquisition*



*color*

*Preprocessing*

*Segmentation*

*Feature extraction*

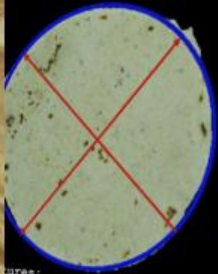
*Clasification*

*Class 'S' Sub-Class '1'*

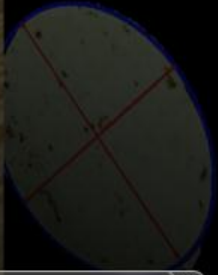
*geometry*

Feature	Value
Intensity (Red)	0.9875
Haralick Tx01-3	0.8978
:	:

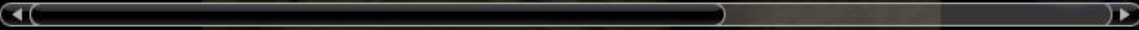


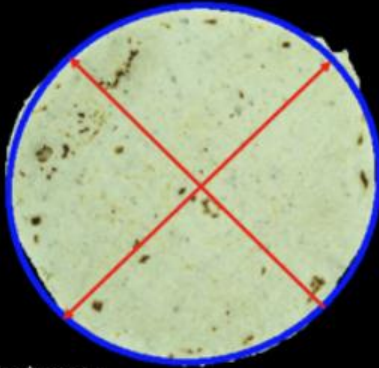


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7.02 cm  
6.58 cm  
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ntea:



# 1 Introduction

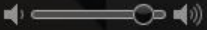
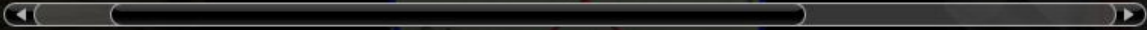


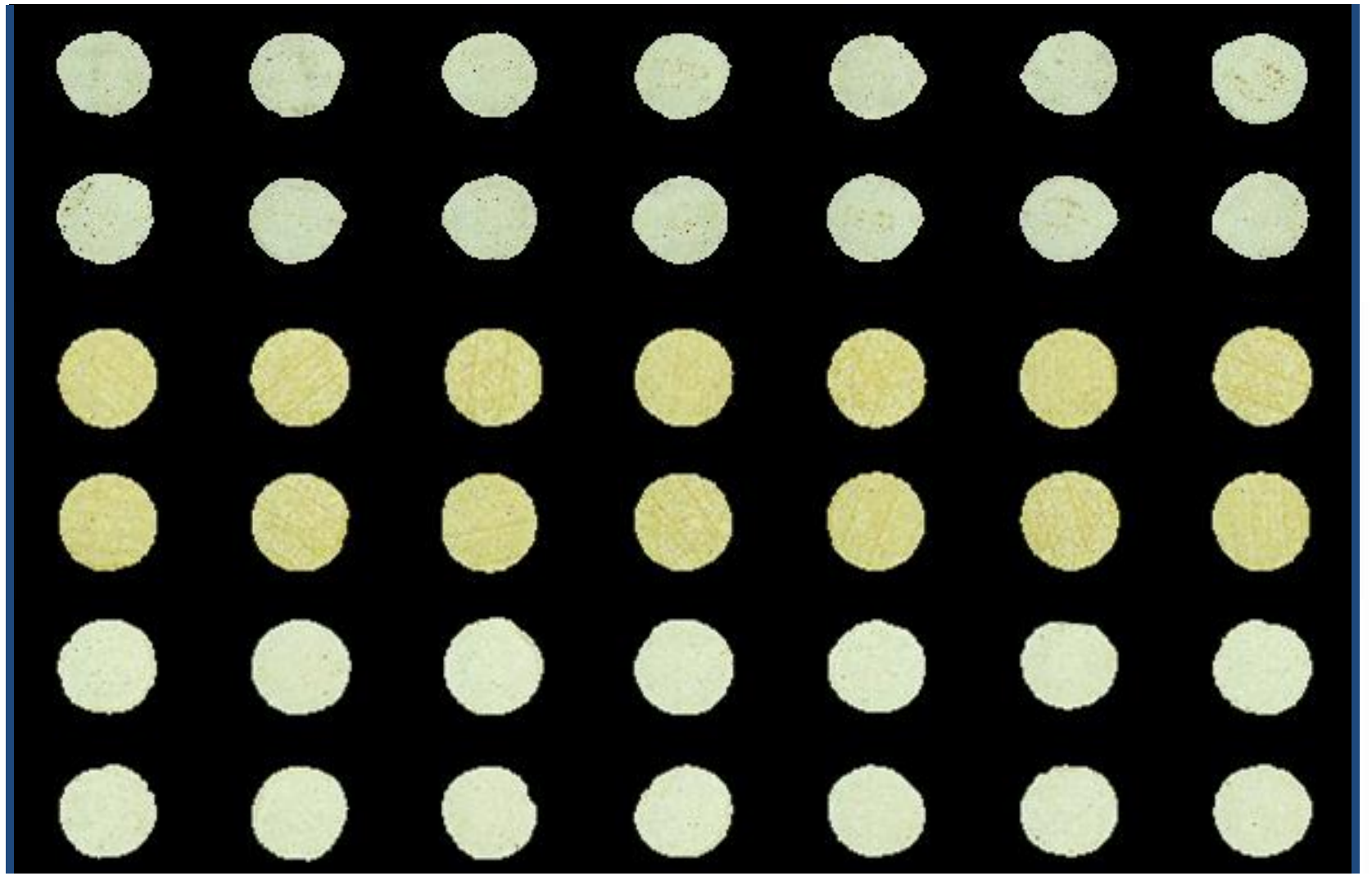


Elliptical Features:  
Major Axis = 7.02 cm  
Minor Axis = 6.58 cm  
Eccentricity = 0.9379

Εκκεντρικότητα = 0.9379  
Μήκος άξιας = 6.58 cm  
Μήκος άξιας = 7.02 cm  
Επιτρεπόμενα βάρη/τόνοι:

## 2 Features











**Geometrical Features:**

**Area** = 145.61 cm<sup>2</sup>

**Perimeter** = 43.50 cm

**Radius** = 6.81 cm

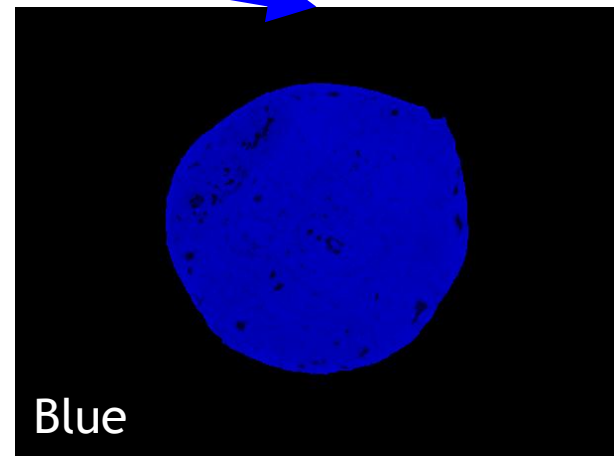
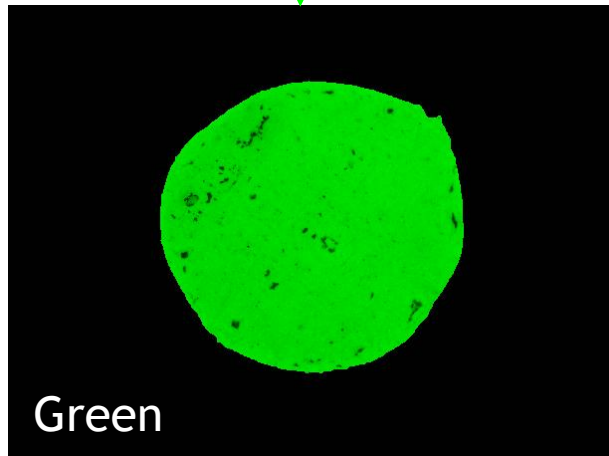
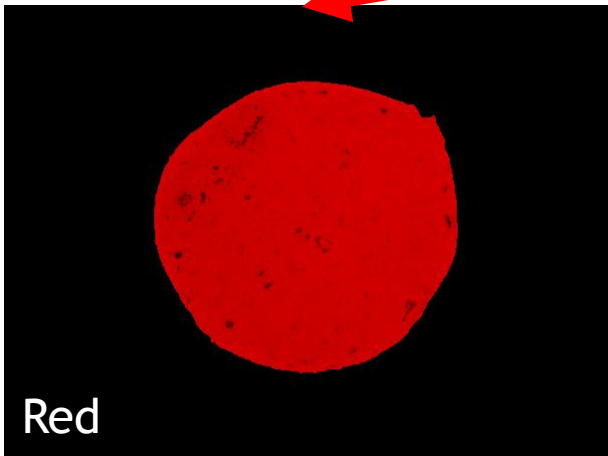
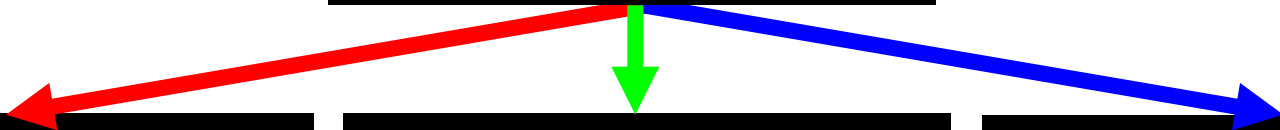


Elliptical Features:

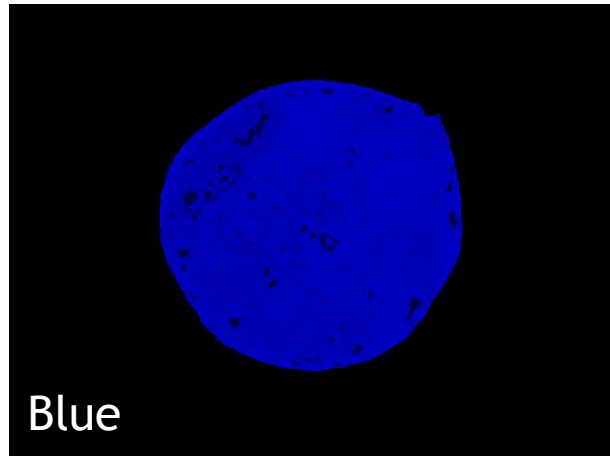
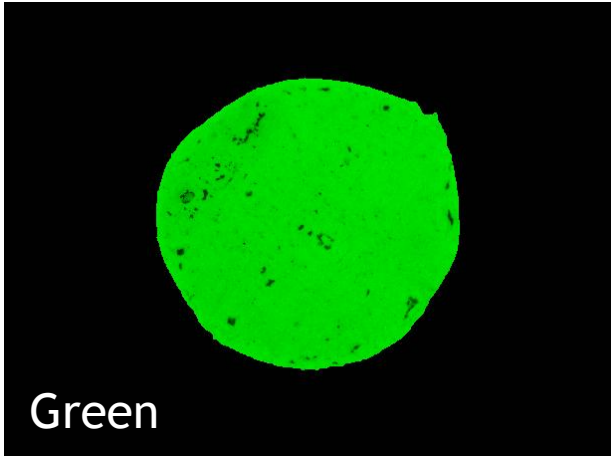
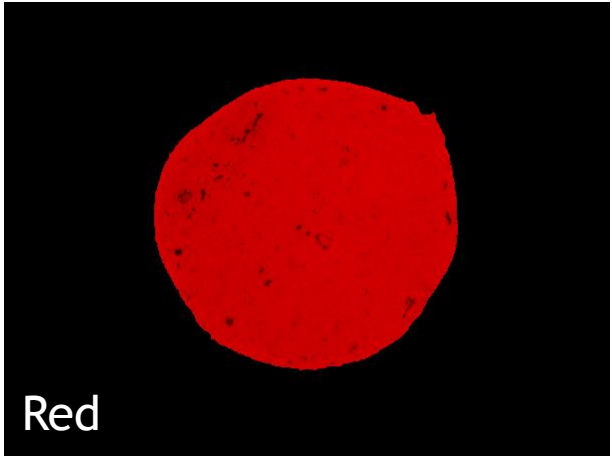
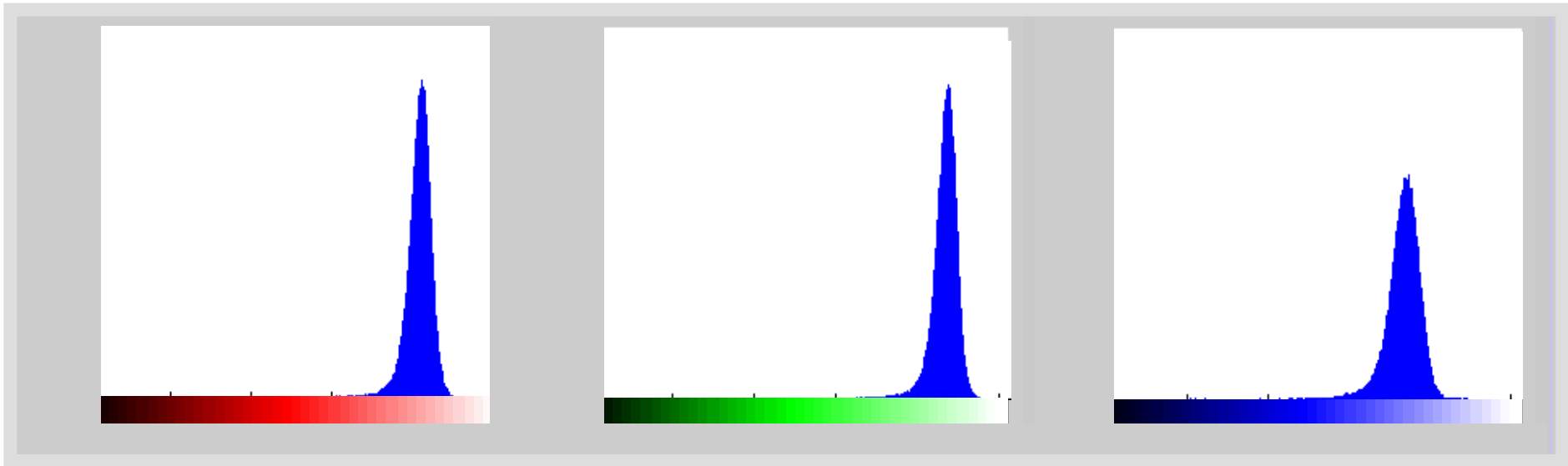
Major Axis = 7.02 cm

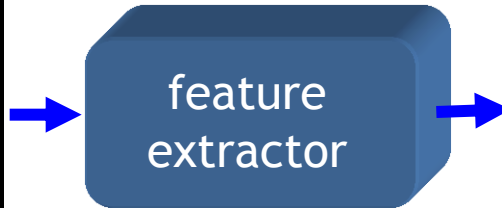
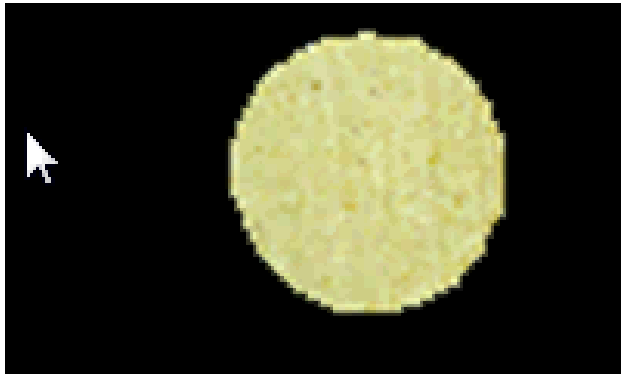
Minor Axis = 6.58 cm

Eccentricity = 0.9379









	Area	Perimeter	Round
9	20036,5	497	1,01
0	20145,75	499,5	1,01
9	19883	496	1,0
1	20024,75	499,25	1,00
9	19595,625	492	1,01

2300 features/tortilla

Std Intensity
11,1221111
9,05365853
11,312249
8,96138
11,5057948
9,11995371
11,3729386
8,89385687
11,7416174
9,15690413
11,8685622
9,03336111
11,6601474
9,26650204
9,24277473
11,5751661
11,7083192
9,08287584
11,8854682
9,29851537
11,9752378
9,5912245
12,3129639
9,19327553
11,9687986
9,4574303
12,2830441
9,54054064

Tx 6,d1(meas T
13,7376765
13,7786132
13,6315424
13,7488131
13,6293801
13,7052516
13,6549845
13,7167724
13,527905
13,6245282
13,5936576
13,7292253
13,5189322
13,7177474
13,8025008
13,7159793
13,6023758
13,7534834
13,6667271
13,7234907
13,6139379
13,6658353
13,5750499
13,7293824
13,4382189
13,6594161
13,4968982
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13,7486446

feature 2

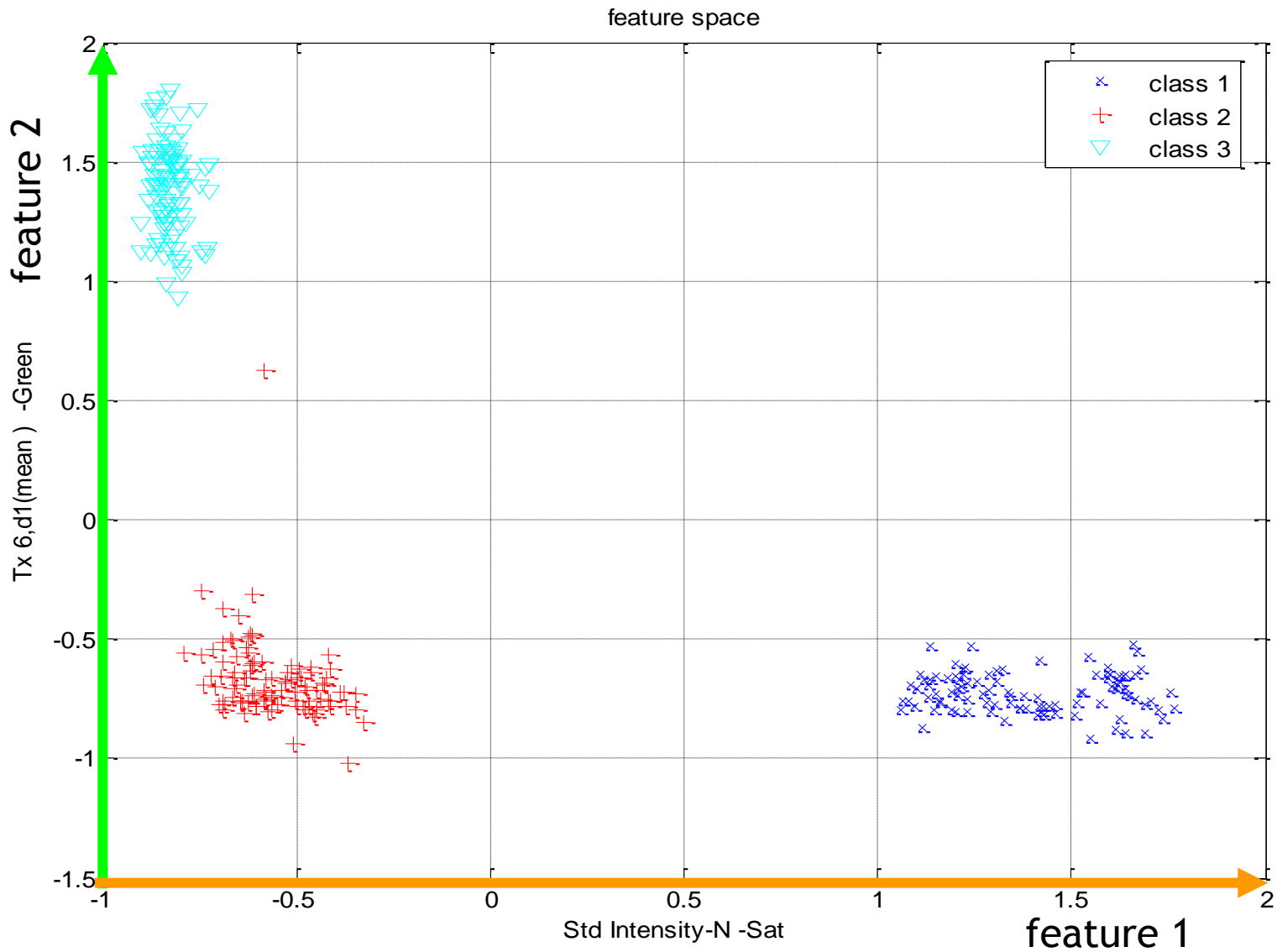


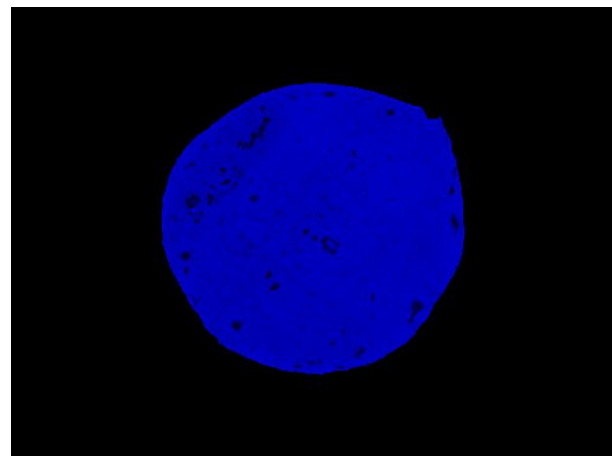
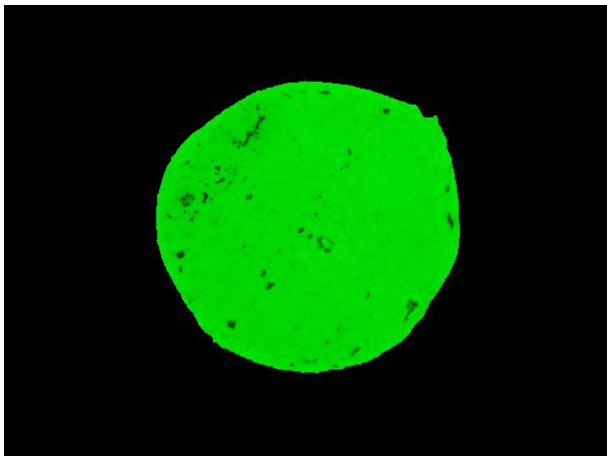
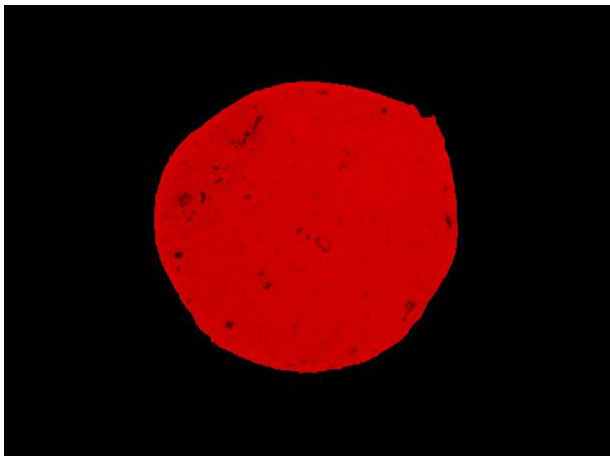
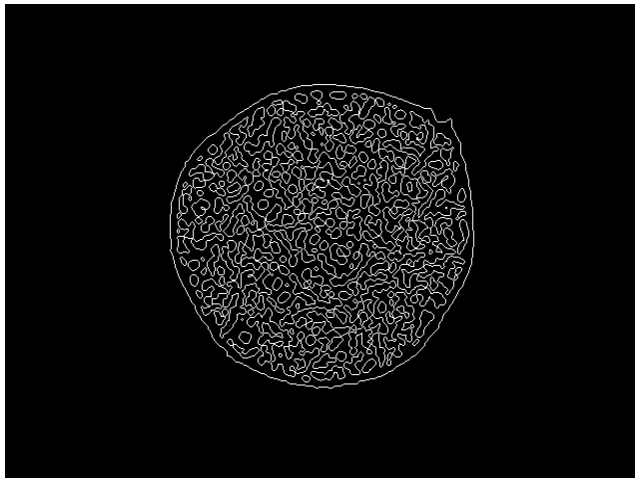
feature 1

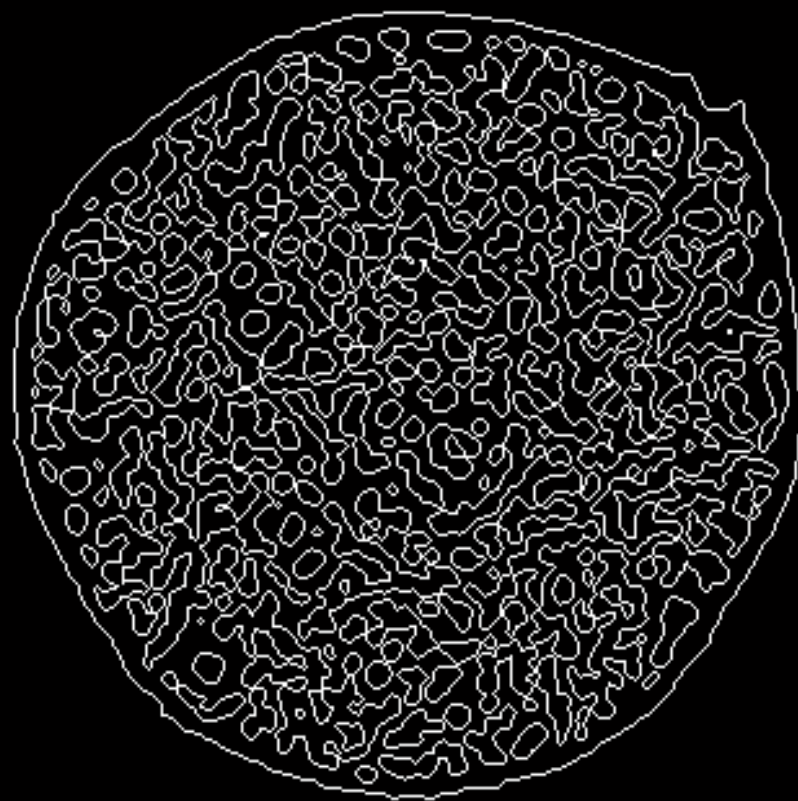


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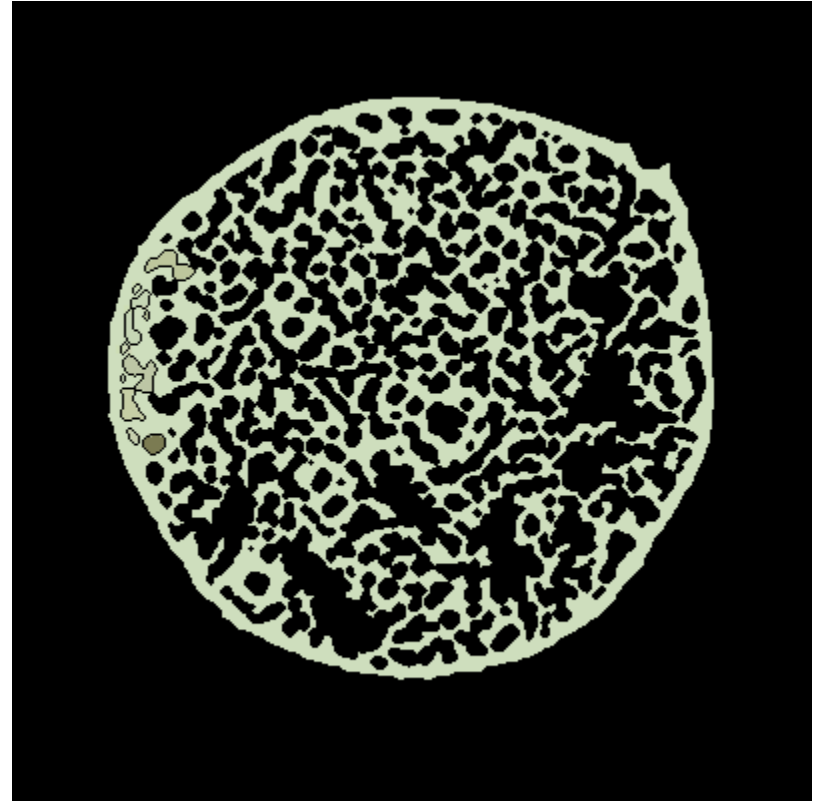
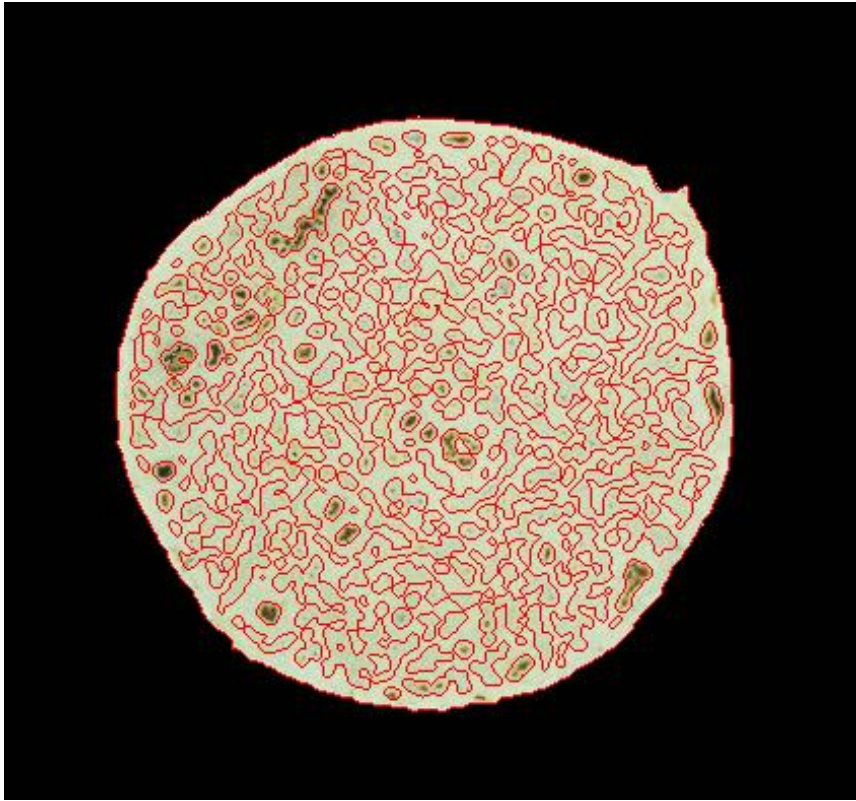
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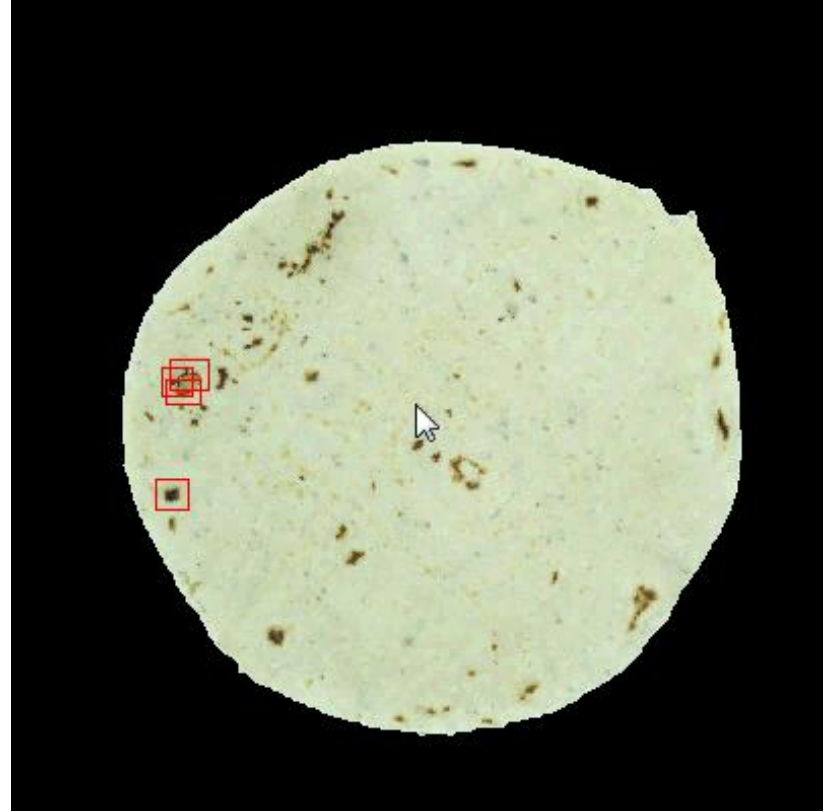
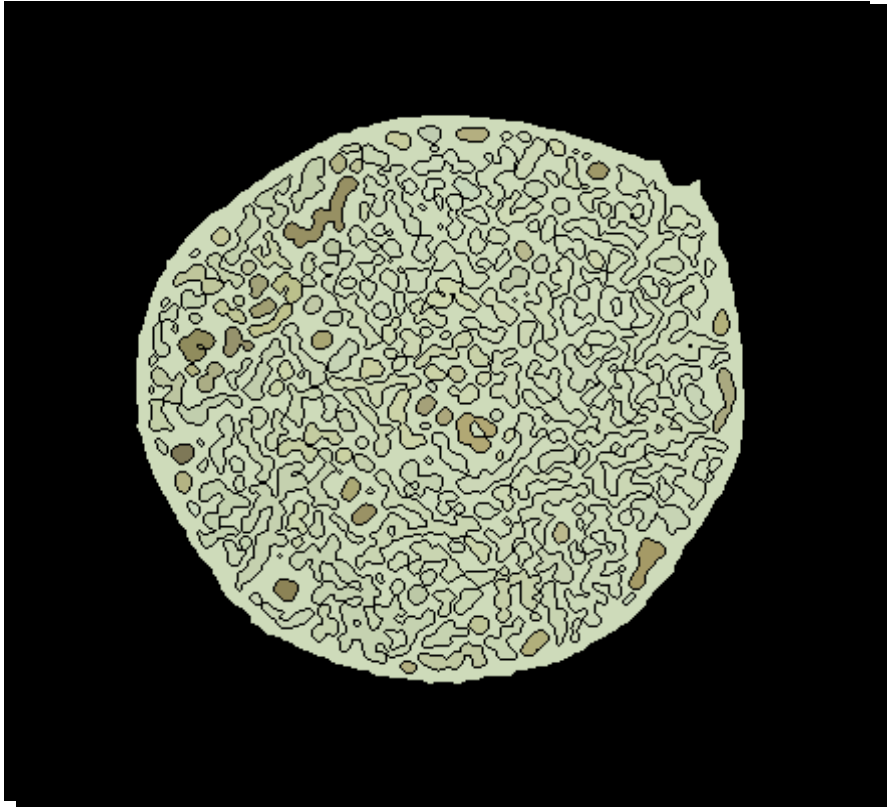


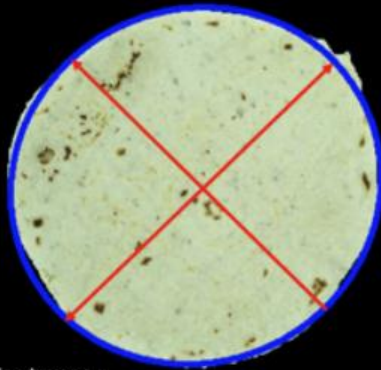








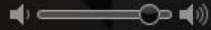
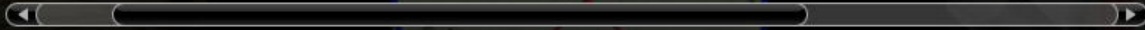


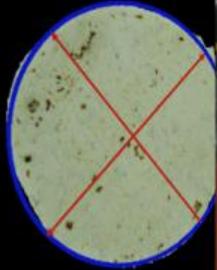


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Minor Axis = 6.58 cm  
Eccentricity = 0.9379

Εκκεντρικότητα = 0.9379  
Μήκος άξιας = 6.58 cm  
Μήκος άξιας = 7.02 cm  
Επιτρεπόμενα βάρη/τόνοι:

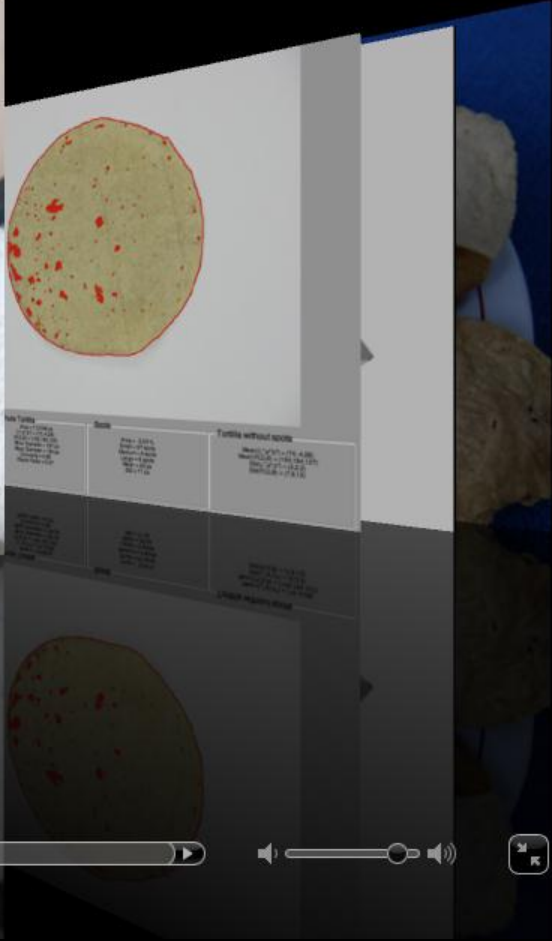
## 2 Features





Elliptical Features:  
Major Axis = 7.02 cm  
Minor Axis = 6.58 cm  
Eccentricity = 0.9379

Ελλειψοειδής = 0.9379  
Μείζον άξονα = 7.02 cm  
Μείζον άξονα = 6.58 cm  
Επιμήκη διαστάση:

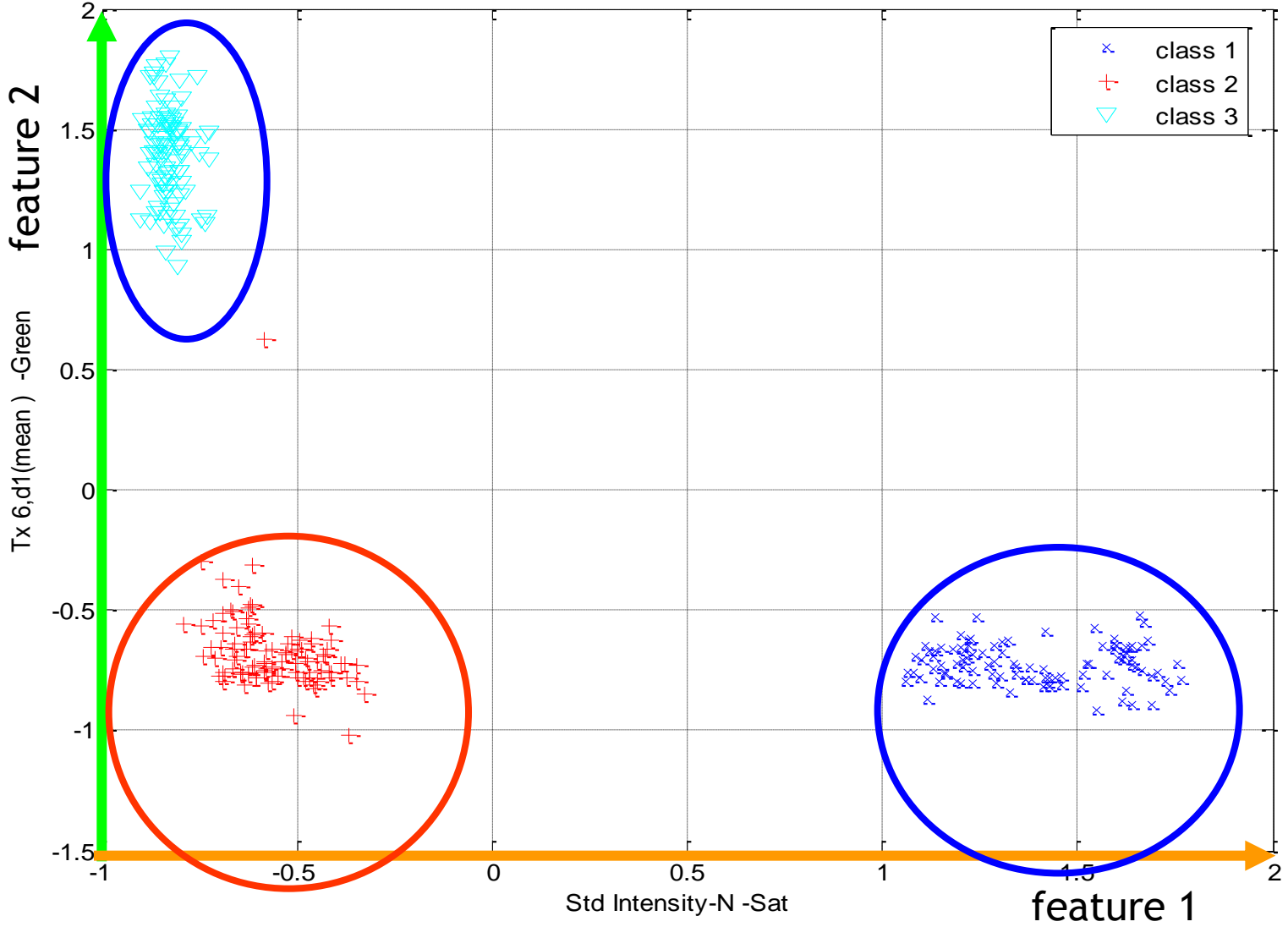


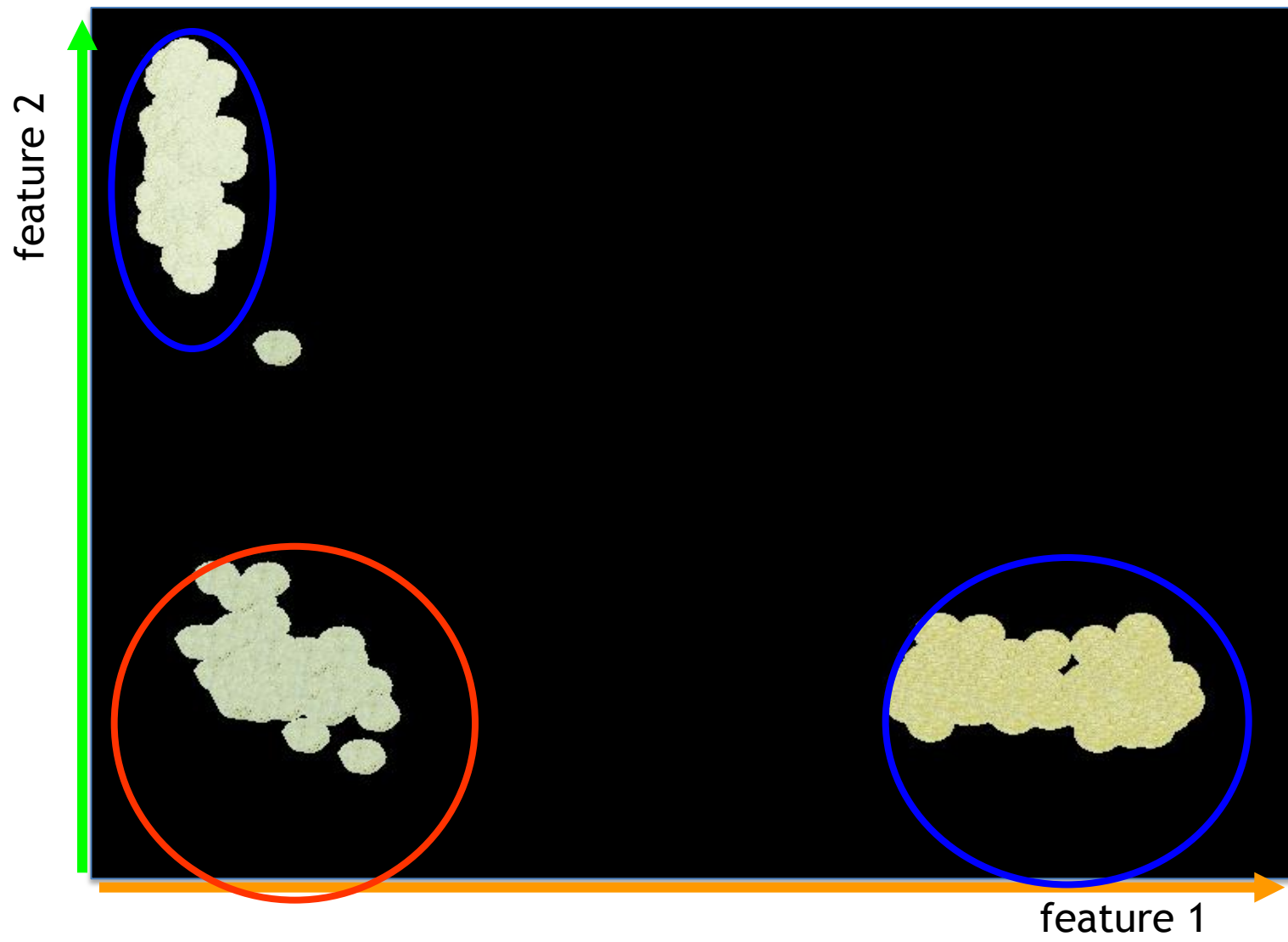
### 3 Classification

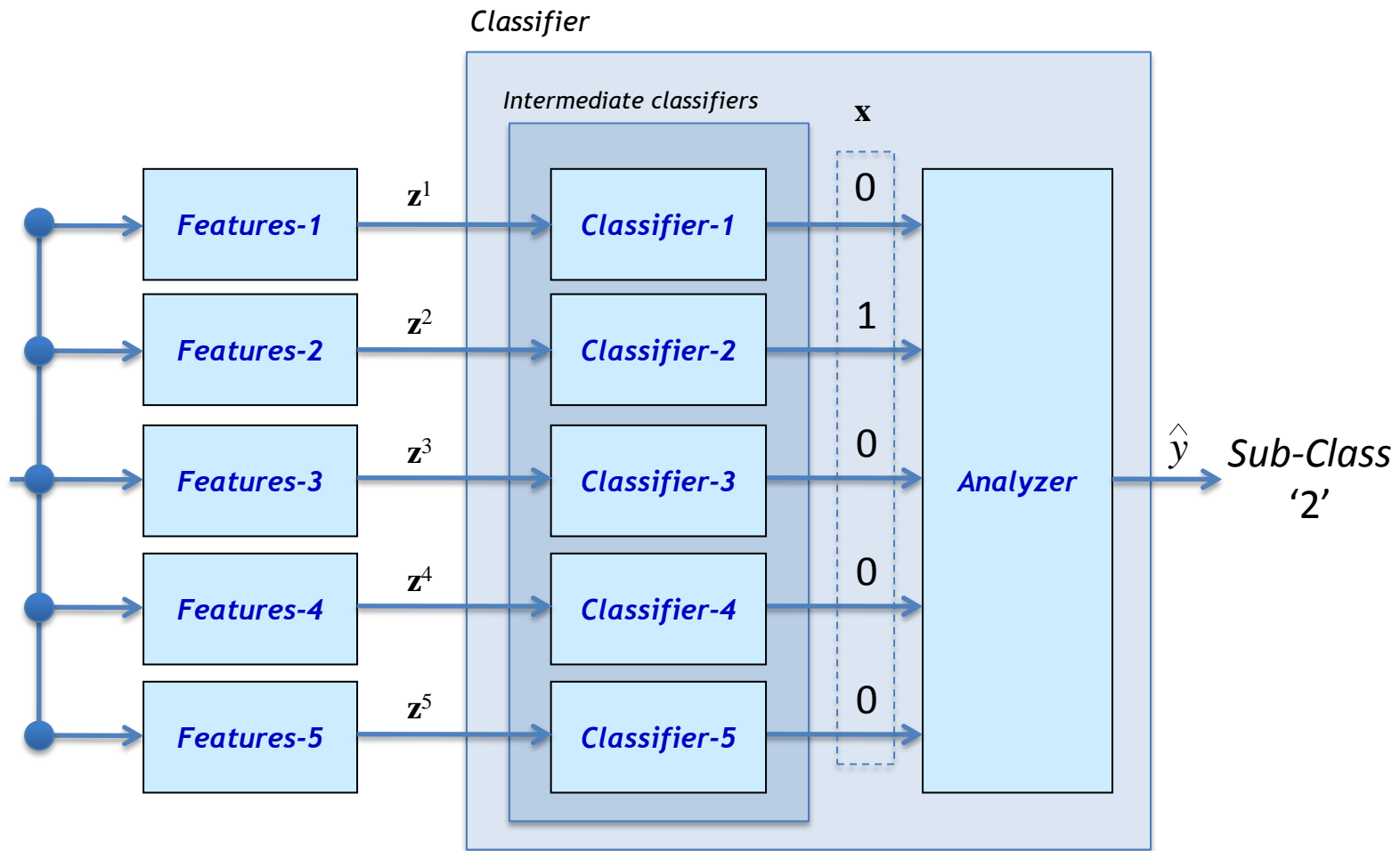




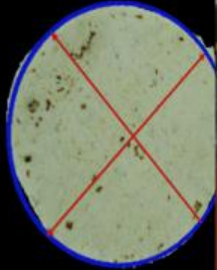
feature space





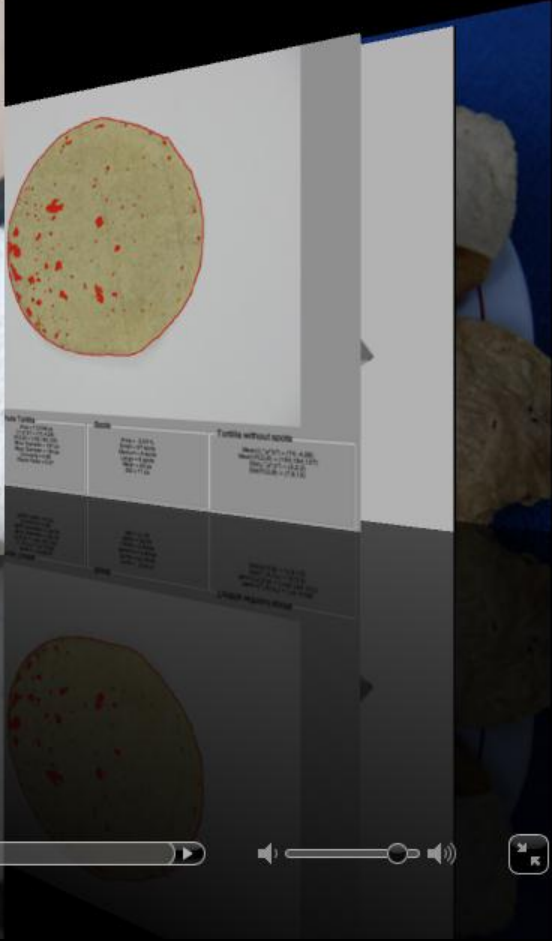






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Ελλειψοειδής = 0.9379  
Μείζον άξονα = 7.02 cm  
Μείζον άξονα = 6.58 cm  
Επιμήκυνση = 0.9379



### 3 Classification





Ellipti  
Major A  
Minor A  
Eccentr  
Eccentr  
Mtor v  
Mtor v  
EITTB7



Expert (2) ■ ■  
System (2) ■ ■

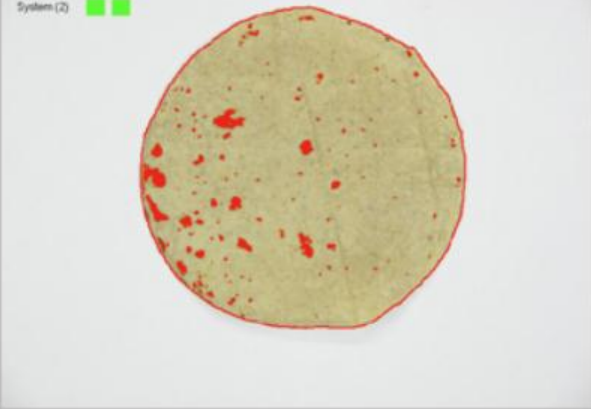
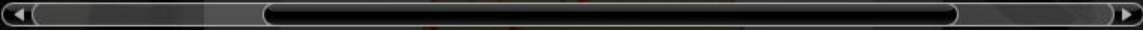


Image	Whole Tortilla	Scots	Tortilla without scots
<input type="button" value="Previous"/> <input type="button" value="Next"/>	Area = 737480 px $L^2 \cdot a^2/b^2 = 175.4126$ $b^2/a^2 = 0.5811041125$ Minor (b)area = 137 px Major (a)area = 1287 px Circularity = 0.28 Round Factor = 0.27	Area = 334 px Shape = 0.94 area Maximum of scots Length = 8 pixels Width = 32 px 200 x 77 px	Mean(L^2 a^2/b^2) = 176.4126 Mean(b^2/a^2) = 0.5811041125 Std(L^2 a^2/b^2) = 23.212 Std(b^2/a^2) = 0.112
<input type="button" value="Quality"/>			
<input type="button" value="Close"/>			
<input type="button" value="Landscape"/> <input type="button" value="Portrait"/>			

**4 Experiments**



Image

X1.01.5.A.JPG



Select Image

Previous

Next

Quality

Characterization

Whole Tortilla

Area = 112854 px  
(L\*,a\*,b\*) = (73,-5,25)  
(R,G,B) = (188,182,131)  
Minor Diameter = 178 px  
Major Diameter = 201 px  
Circularity = 0.89  
Ripple Factor = 0.48

Spots

Area = 4.14 %  
Small = 194 spots  
Medium = 14 spots  
Large = 5 spots  
Mean = 21 px  
Std = 59 px

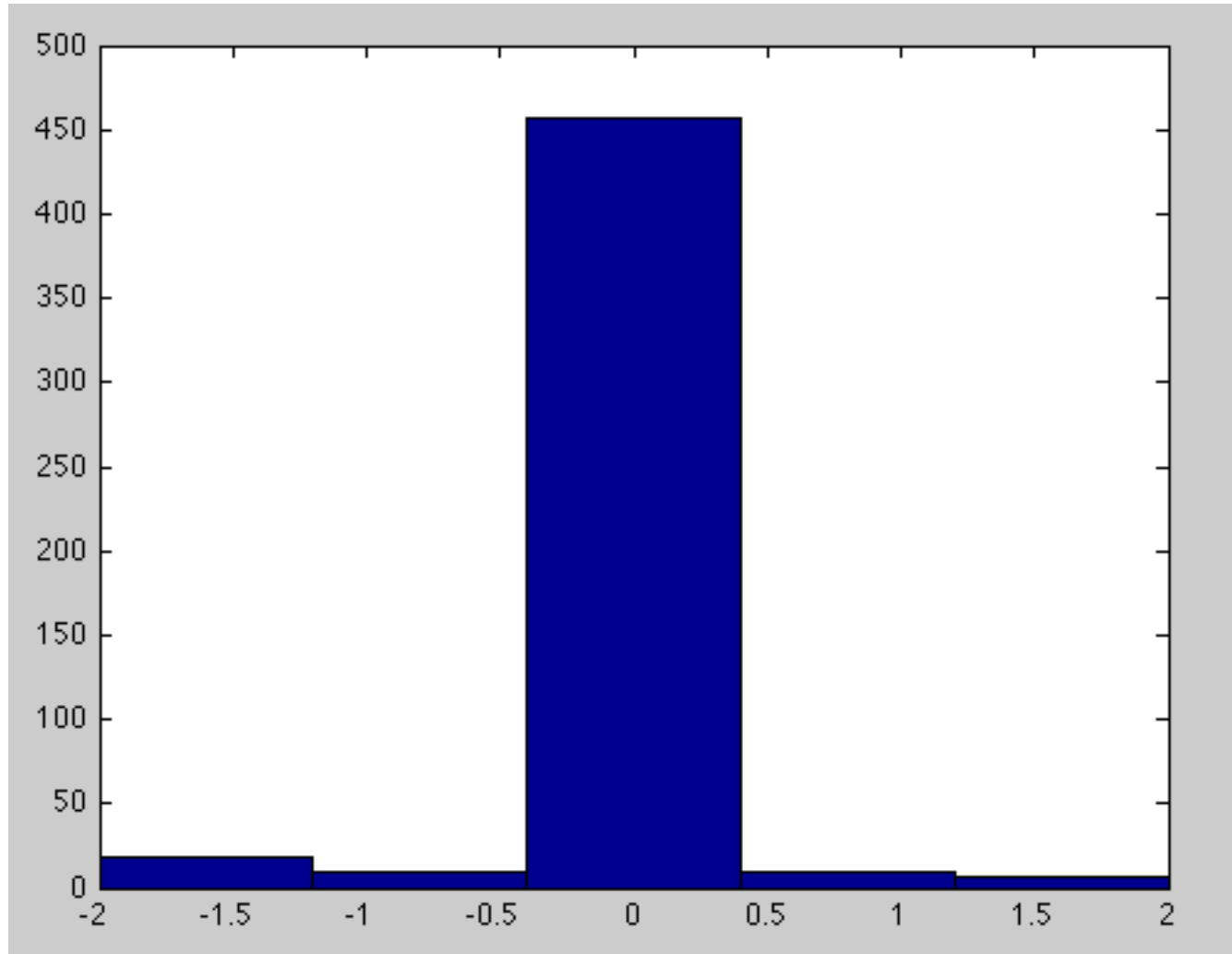
Tortilla without spots

Mean(L\*,a\*,b\*) = (74,-5,25)  
Mean(R,G,B) = (189,183,133)  
Std(L\*,a\*,b\*) = (4,2,3)  
Std(R,G,B) = (9,11,15)

Characterization

> It is too burnt. Too many large spots. Flour is too dark.

# Difference between Computer Vision System and Human Classification





Ellipti  
Major A  
Minor A  
Eccentr  
Eccentr  
Mtor v  
Mtor v  
EITTB7



Expert (2) ■ ■  
System (2) ■ ■

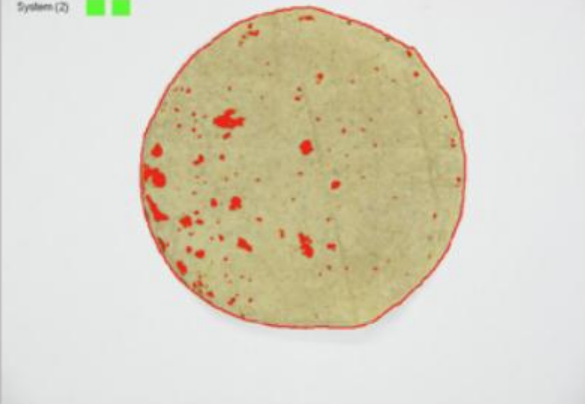
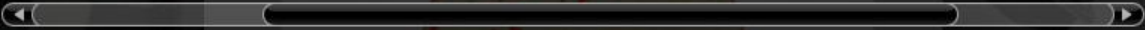
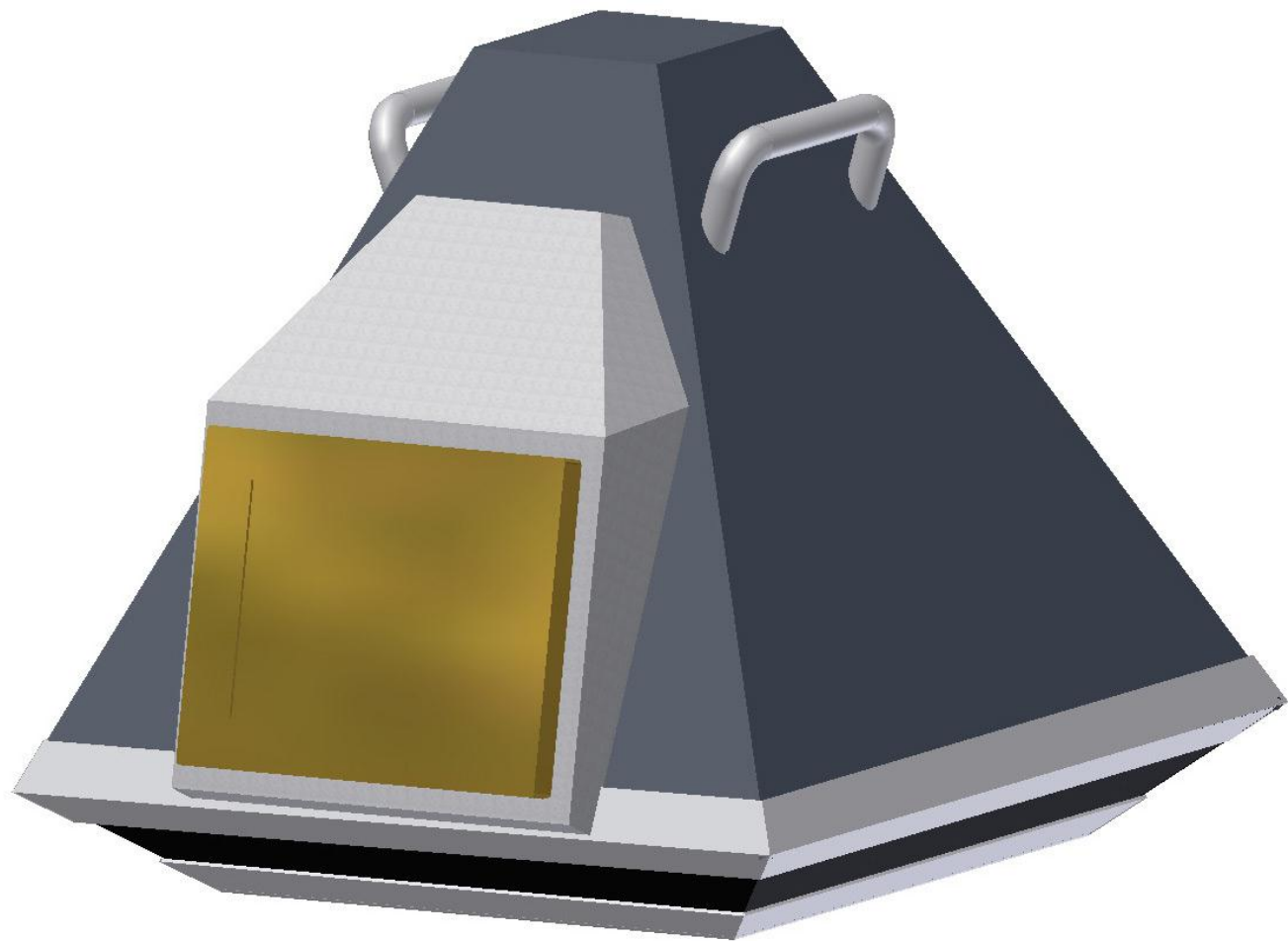


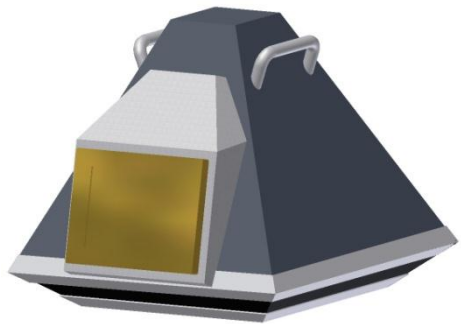
Image	Whole Tortilla	Scots	Tortilla without scots
<input type="button" value="Previous"/>	Area = 131460 px L <sup>2</sup> = 271 = 173 x 156 W <sup>2</sup> = 136 = 118 x 116 Minor (radius) = 137 px Major (radius) = 140 px Circularity = 0.98 Hough Factor = 0.07	Area = 334 px Length = 27 pixels Maximum of scots Length = 8 pixels Width = 10 px DIP = 71 px	Mean <sup>2</sup> = 971 = 74 x 131 Mean <sup>2</sup> = 138 = 118 x 116 SD <sup>2</sup> = 212 = 14 x 142 SD <sup>2</sup> = 212 = 14 x 142
<input type="button" value="Next"/>	Area = 131460 px L <sup>2</sup> = 271 = 173 x 156 W <sup>2</sup> = 136 = 118 x 116 Minor (radius) = 137 px Major (radius) = 140 px Circularity = 0.98 Hough Factor = 0.07	Area = 334 px Length = 27 pixels Maximum of scots Length = 8 pixels Width = 10 px DIP = 71 px	Mean <sup>2</sup> = 971 = 74 x 131 Mean <sup>2</sup> = 138 = 118 x 116 SD <sup>2</sup> = 212 = 14 x 142 SD <sup>2</sup> = 212 = 14 x 142
<input type="button" value="Quality"/>	Area = 131460 px L <sup>2</sup> = 271 = 173 x 156 W <sup>2</sup> = 136 = 118 x 116 Minor (radius) = 137 px Major (radius) = 140 px Circularity = 0.98 Hough Factor = 0.07	Area = 334 px Length = 27 pixels Maximum of scots Length = 8 pixels Width = 10 px DIP = 71 px	Mean <sup>2</sup> = 971 = 74 x 131 Mean <sup>2</sup> = 138 = 118 x 116 SD <sup>2</sup> = 212 = 14 x 142 SD <sup>2</sup> = 212 = 14 x 142

**4 Experiments**

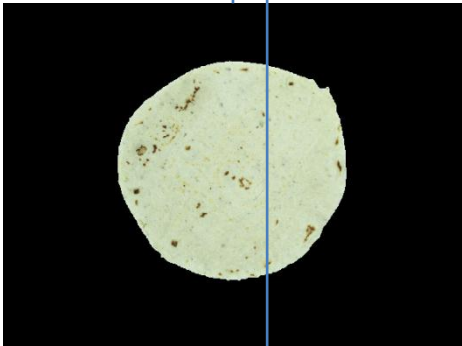




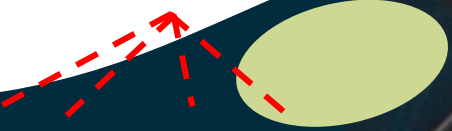




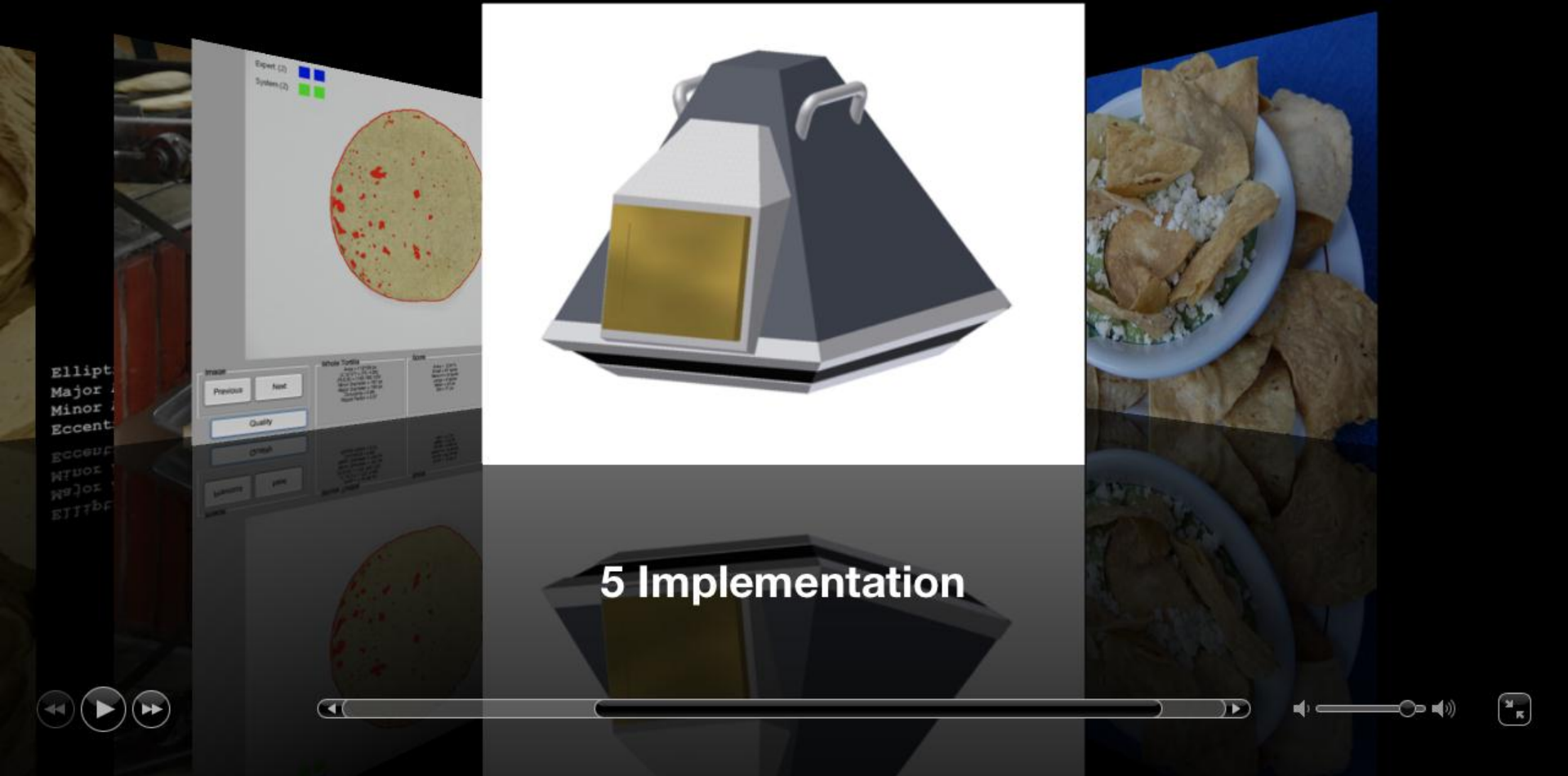
server



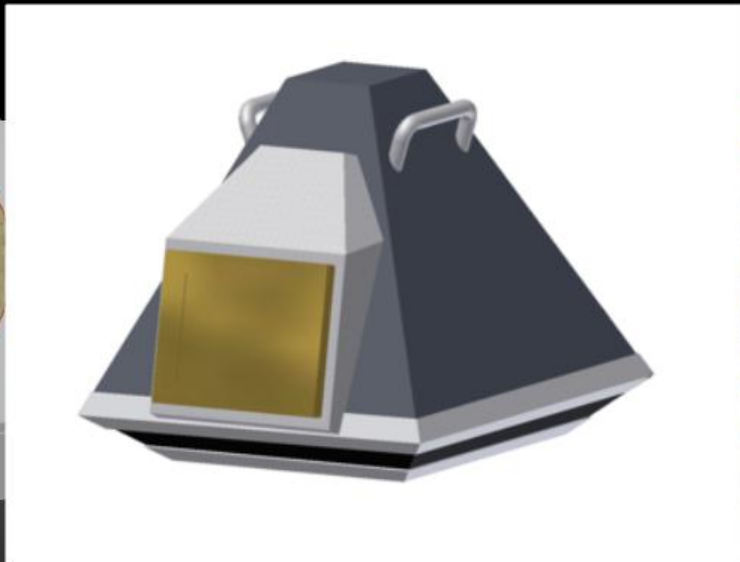
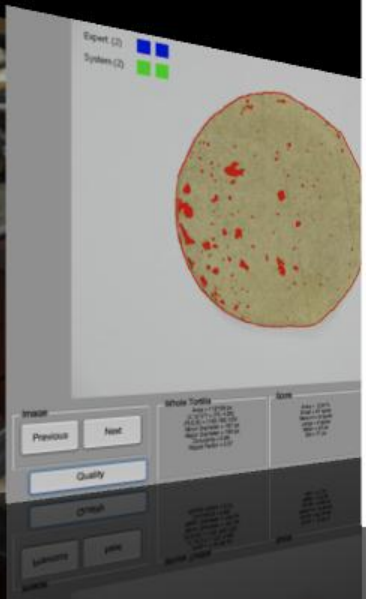
Quality '4'





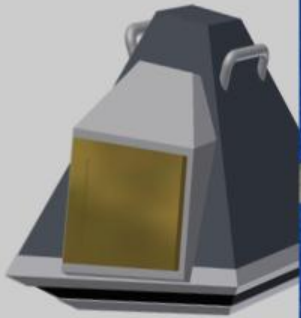


Ellipt  
Major  
Minor  
Eccent  
Eccen  
RTUOL  
N9JOK  
E111br

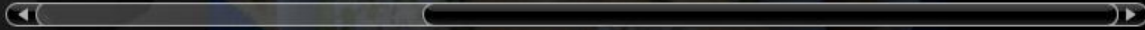


# 5 Implementation





## 6 Conclusions





## Quality Classification of Corn Tortillas using Computer Vision

Domingo Mery<sup>\*a</sup>, Jorge J. Chanona-Pérez<sup>b</sup>, Alvaro Soto<sup>a</sup>, José Miguel Aguilera<sup>a</sup>, Aldo Cipriano<sup>a</sup>, Nayeli Veléz-Rivera<sup>b</sup>, Israel Arzate-Vázquez<sup>b</sup>, Gustavo F. Gutiérrez-López<sup>b</sup>

<sup>a</sup>*Pontificia Universidad Católica de Chile*

<sup>b</sup>*Instituto Politécnico Nacional de México*

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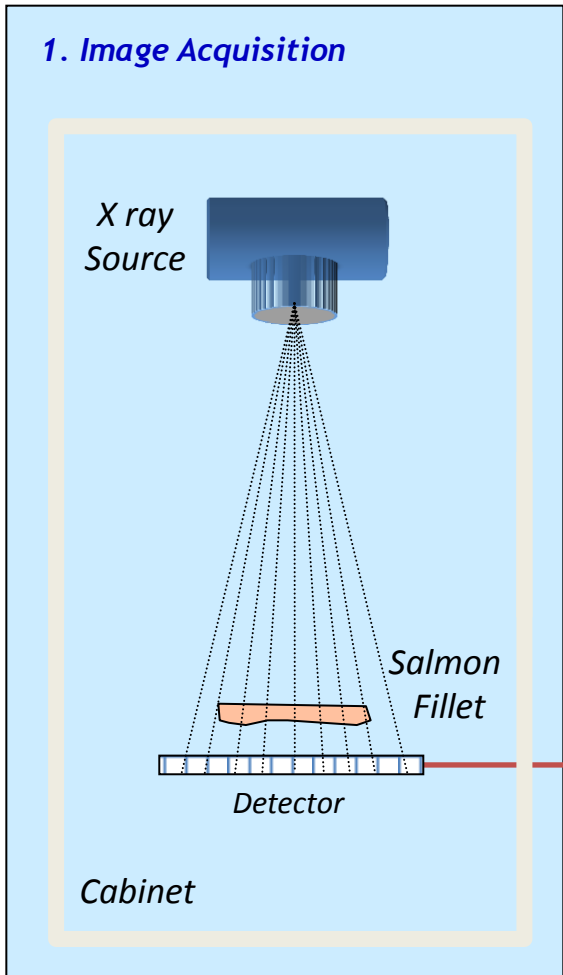
### Abstract

Computer vision is playing an increasingly important role in automated visual inspection of foods. In production of tortillas, however, the quality control is still done by human operators that may yield to misclassification due to subjectivity and fatigue of operators. For this reason, we developed a computer vision methodology to classify the quality of corn tortillas automatically according to five hedonic sub-classes given by a sensorial panel. The proposed methodology analyzed 750 corn tortillas obtained from 15 different Mexican small, medium and large commercial stores. More than 2300 geometric and color features were extracted from 1500 images captured on both sides of the tortillas. After a feature selection algorithm, in which the most relevant features were selected for the classification of the five sub-classes, only 64 features were required to design a classifier based on support vector machines. Cross validation yielded a performance of 95% in the classification of the five hedonic sub-classes. Additionally, using only 10 of the selected features and a simple statistical classifier, it was possible to determine the origin of the tortillas according to production scale with a performance of 96%. We believe that the proposed methodology opens up new possibilities in the field of automated visual inspection of tortillas.

*Key words:* Corn tortillas, computer vision, automated visual inspection, sensorial panel.

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**2. Preprocessing**

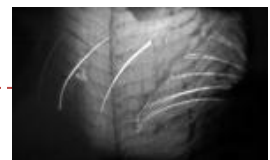
**3. Segmentation**

**4. Feature Extraction**

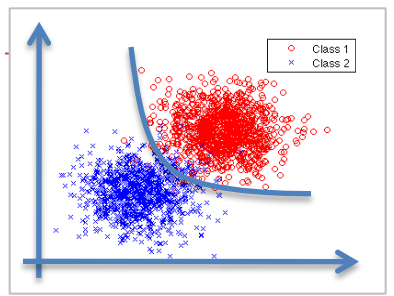
**5. Classification**

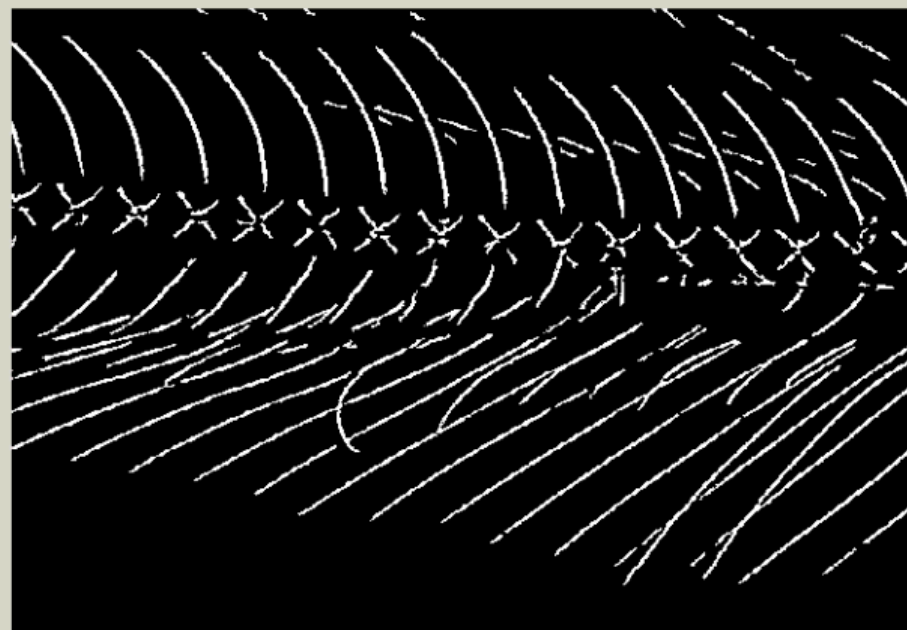
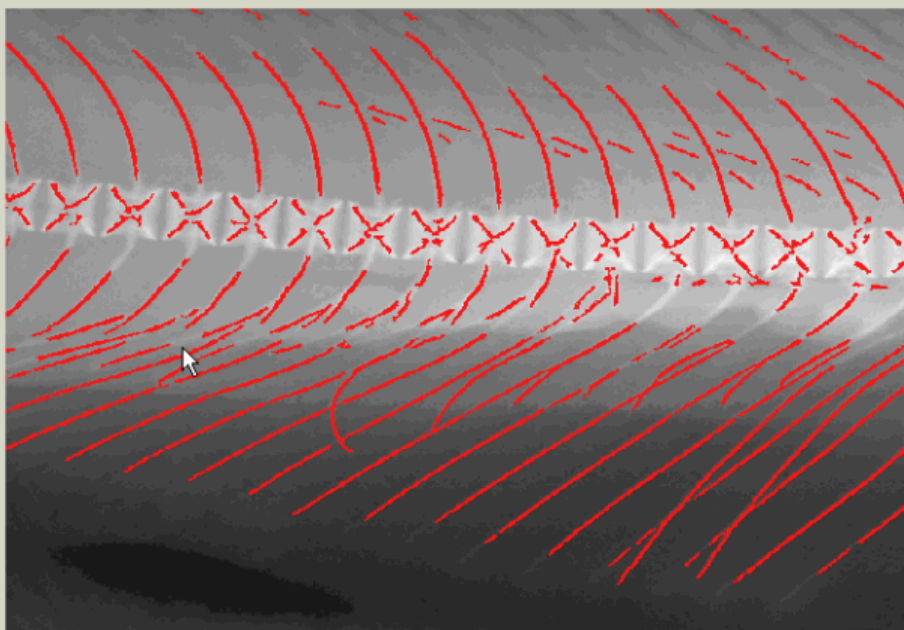
**6. Postprocessing**

**“fishbones”**



Feature	Value
Intensity	0.9875
Tx01-3	0.8978
:	:





Capturar y detectar espinas

Calibrar

Opciones

Herramientas

Zoom

+

-

Mostrar espinas en imagen

Sensibilidad de detección



Resultados

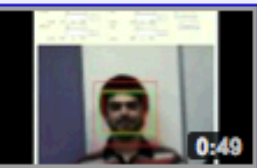
tiempo convolucion + bwareaopen(20) + DFT + LBP + clasificacion: 3.218000

Salir

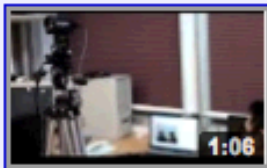
Reiniciar sistema



<http://www.youtube.com/user/grimachile>



Active Face Recognition (Part 1)



Active Face Recognition (Part 2)



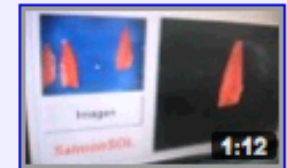
Automated Visual Inspection of



Face Recognition with Decision



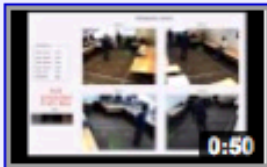
Automated Detection of Fish



Automated Visual Inspection of



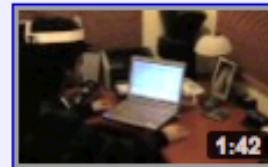
Group Detecting using depth



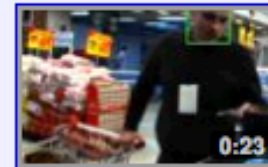
People detection using sliding-box



Real Time People Counting using



Head Tracking System using



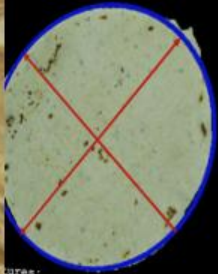
Face Tracking with with complex



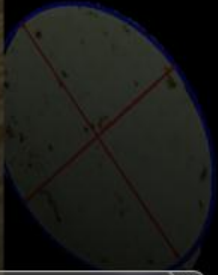
Face Tracking with with fast



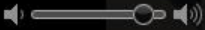
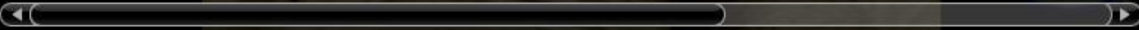
<http://grima.ing.puc.cl>



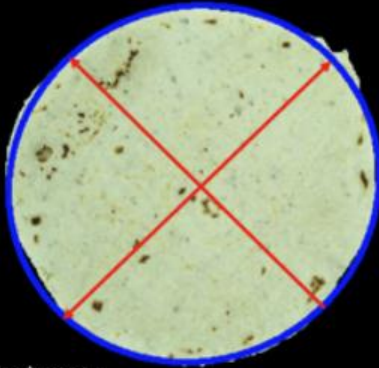
ures:  
7.02 cm  
6.58 cm  
0.9379  
0.3218  
6.28 cm  
1.05 cm  
ntea:



# 1 Introduction



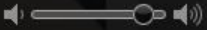
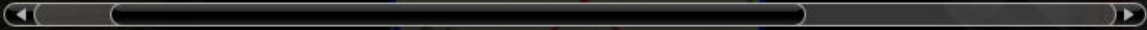


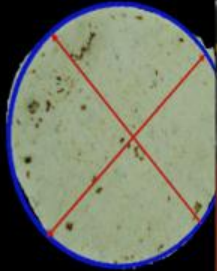


Elliptical Features:  
Major Axis = 7.02 cm  
Minor Axis = 6.58 cm  
Eccentricity = 0.9379

Εκκεντρικότητα = 0.9379  
Μείζον άξια = 7.02 cm  
Μειζον άξια = 6.58 cm  
Επιτρεχόμενα βασίματα:

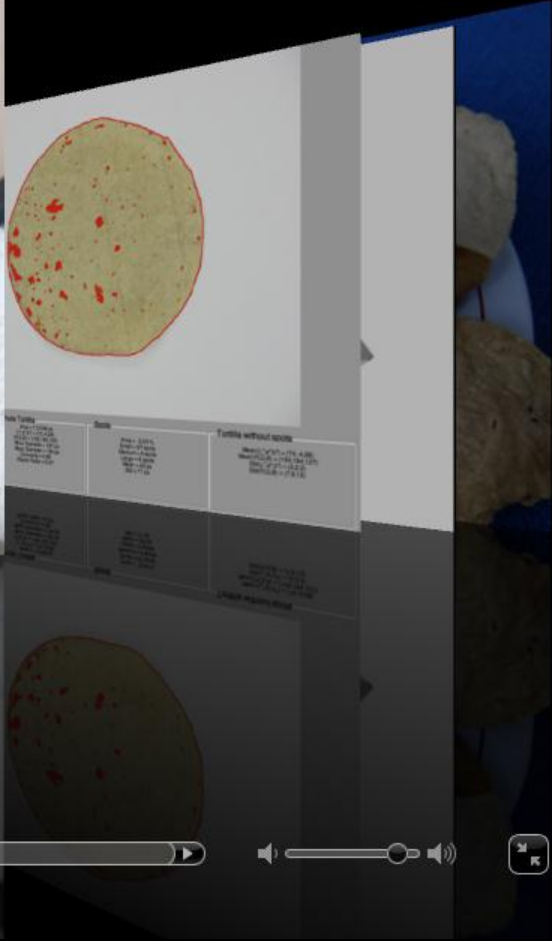
## 2 Features



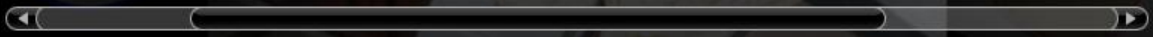


Elliptical Features:  
Major Axis = 7.02 cm  
Minor Axis = 6.58 cm  
Eccentricity = 0.9379

Ελλειψοειδής = 0.9379  
Μείζον άξονα = 7.02 cm  
Μειζον άξονα = 6.58 cm  
Επιμήκυνση = 0.9379



### 3 Classification





Ellipti  
Major A  
Minor A  
Eccentr  
Eccentr  
Mtor v  
Mtor v  
EIT7b7

Expert (2) ■ ■  
System (2) ■ ■

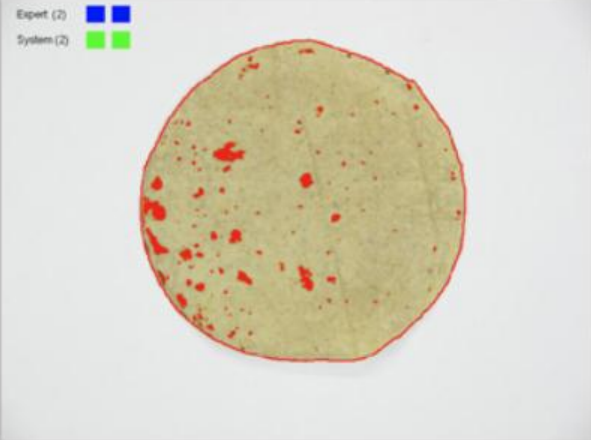
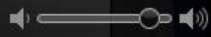
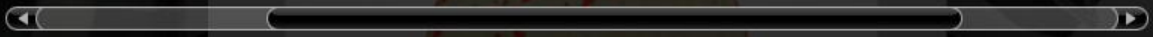
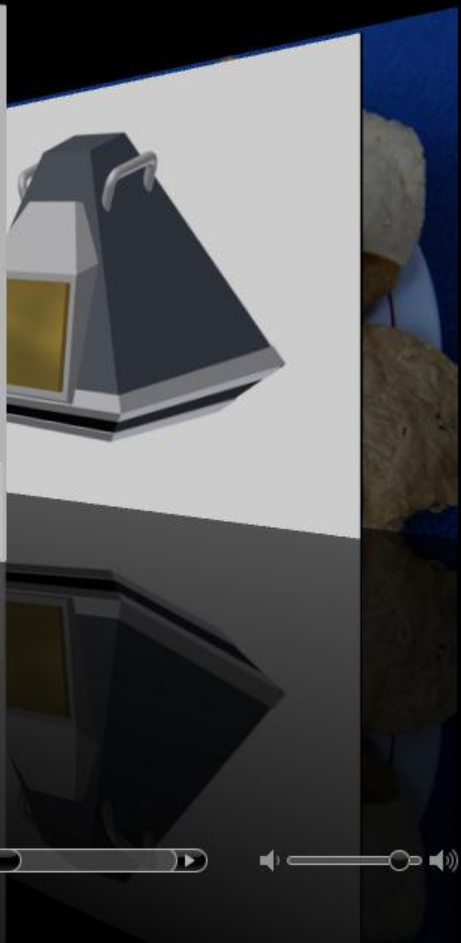



Image	Whole Tortilla	Scots	Tortilla without scots
<input type="button" value="Previous"/> <input type="button" value="Next"/>	Area = 131480 px L <sup>2</sup> = 271 = 175.4285 W <sup>2</sup> = 136 = 116.6125 Minor (Square) = 127 px Major (Square) = 136 px Circularity = 0.98 Hough Factor = 0.07	Area = 334 px Length = 27 square Minimum = 9 square Length = 9 square Width = 30 px 22 x 27 px	Mean <sup>2</sup> = 971 = 74.4285 Mean <sup>2</sup> = 136 = 116.6125 Std <sup>2</sup> = 21.25 Std <sup>2</sup> = 21.25
<input type="button" value="Quality"/>			
<input type="button" value="Close"/>			
<input type="button" value="Previous"/> <input type="button" value="Next"/>			
<input type="button" value="Quality"/>			
<input type="button" value="Close"/>			

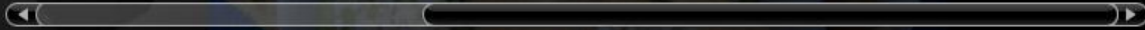
# 4 Experiments







## 6 Conclusions





# Quality Classification of Tortillas using Computer Vision

Domingo Mery, Jorge Chanona, Álvaro Soto,  
José Miguel Aguilera, Aldo Cipriano, Nayeli  
Vélez, Israel Arzate, Gustavo Gutiérrez

UNIVERSIDAD CATOLICA DE CHILE

INSTITUTO POLITÉCNICO NACIONAL DE MÉXICO

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