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INFLUENCE OF NOSE IN FACIAL EXPRESSION DETECTION

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CERTIFICATE OF APPROVAL

This foregoing project is hereby approved as a creditable study of an Honours subject carried out and presented in a satisfactory manner to warrant its acceptance as a perquisite to the Computer Science Department for which it has been submitted.

It is understood that by this approval the undersigned do not endorse or approve any statement made,opinion expressed or conclusion drawn in there but approves the work only for the purpose for which it has been submitted.

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TO WHOM IT MAY CONCERN

I certify that the project "Influence of nose in facial expression detection" is a bonafide work, carried out by Abhinandan Roy, Sujashnaskar and Joyjyoti Das under my supervision.

They are known to me since the last three years. They are very hard working students of this institute and also competent to work in any sort of project.

They have worked sincerely and regularly on this project and completed the assigned work quite satisfactorily.

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CONTENTS

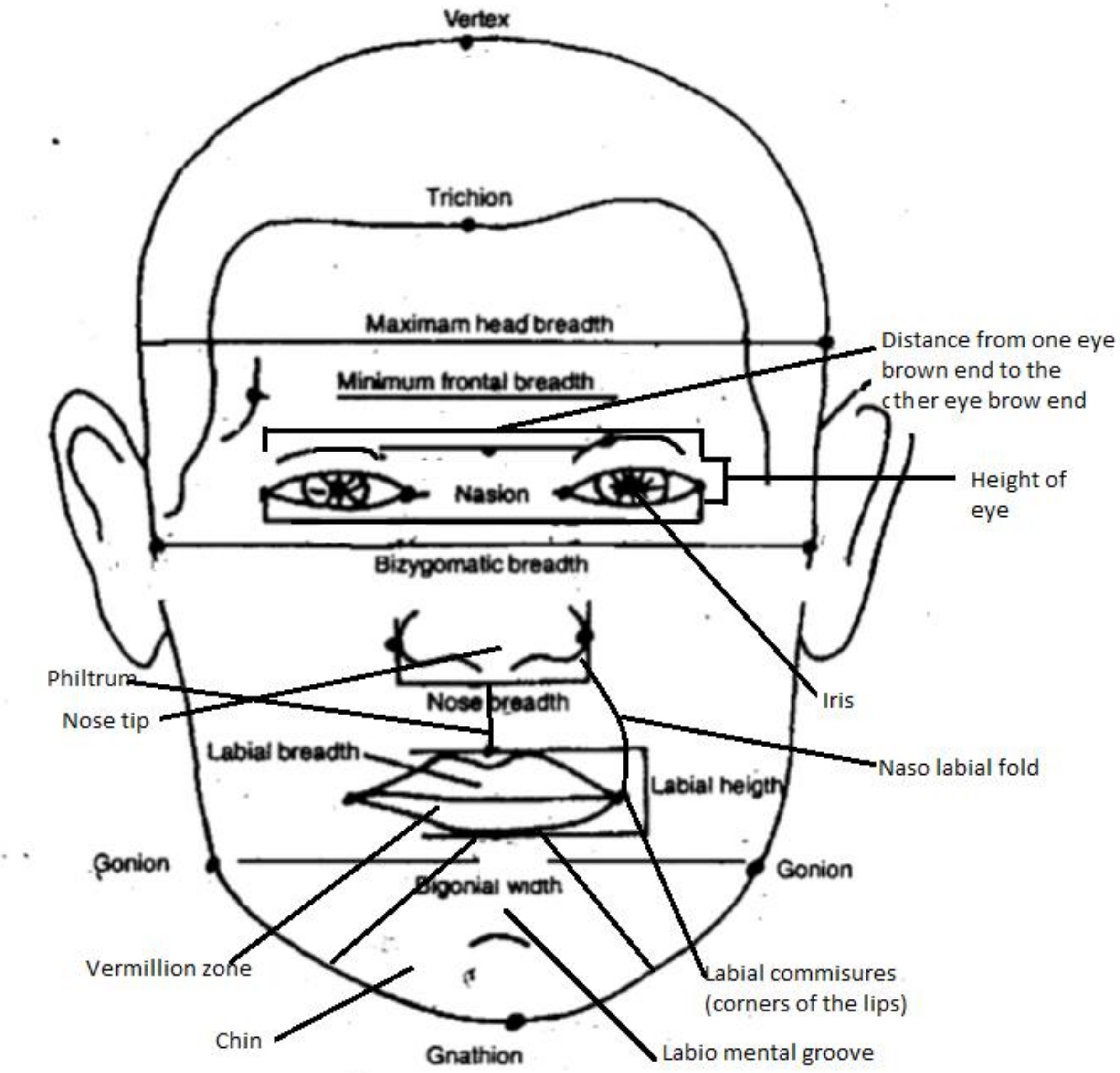
INFLUENCE OF NOSE IN FACIAL EXPRESSION DETECTION

Abstract:

This paper of ours deals primarily with the various landmarks on the nose that could be used to accurately determine a human face. The parameters could also be used to determine various facial expressions in the human face. Along with face recognition, these nodal points on the face can also be used for face recognition. We have done a thorough study on the various research works that have been done on facial recognition and detection and the parameters that each of these papers have used. This paper describes a face detection framework that is capable of processing images extremely rapidly while achieving high detection rates. There are three key contributions. The first is the introduction of a new image representation called the "Integral Image" which allows the features used by our detector to be computed very quickly. The second is a simple and efficient classifier which is built using the AdaBoost learning algorithm (Freund and Schapire, 1995) to select a small number of critical visual features from a very large set of potential features. The third contribution is a method for combining classifiers in a "cascade" which allows background regions of the image to be quickly discarded while spending more computation on promising face-like regions. A set of experiments in the domain of face detection is presented. This paper proposes a method which combines Sobel edge detection operator and soft-threshold wavelet de-noising to do edge detection on images which include White Gaussian noises. In recent years, a lot of edge detection methods are proposed. The commonly used methods which combine mean de-noising and Sobel operator or median filtering and Sobel operator can not remove salt and pepper noise very well. In this paper, we firstly use soft-threshold wavelet to remove noise, then use Sobel edge detection operator to doedge detection on the image.

Introduction:

Human face plays an important role in our social interaction and to represent a person's identity. Thus, detection of the human face and then extracting the facial features of the face is an important ability with a variety of applications such as human face recognition, computer interactions, video conferencing etc. Using the human face as a key to security, biometric face recognition technology has received significant attention in the past years. Face recognition has more advantages over other biometric systems using finger print, palm print etc. This is because facial recognition is a non-contact process. Thus a study about the various parameters of the face is very necessary to accurately understand the various nodal points on the face which could be used to design an ideal human face recognition or face detectionsystem.In this paper we are detecting the nose and studying its various parameters as a part of the face detection and expression recognition.



The frontal pose of the face depicting few details of the side pose of the face (edited)

The study:

The Human face consists of a variety of parameters or nodal points that could be used to accurately determine the face and can also be used for face recognition, detection and can also be used for determining the facial expressions. Among the most important landmarks of the face that we have listed down that could be used to design facial recognition or face detection systems ,we have worked with the nose and its details are explained later.

Nose

Nose is one of the important landmarks in the face that is used to detect particular face. Every human faces have a nose but the structure of the nose might vary from person to person.The nose can also be characterized by two dark regions, corresponding to the nostrils, and a light region, corresponding to the reflex of the light on the nose tip.

The various features of the nose which are useful for detection of the nose as well as facial recognition and detection are:

a. Both the corners of the nostrils.(Width of the nose)

i. The corners of the nostrils are measured to determine the width of the nose. This implies that the rightmost corner of the right nostril and the leftmost corner of the left nostril is to be measured.

1. Related works:

a. Uses the SUSAN method for corner and border extraction to extract both the corners of the nose and which are then stored into a database for further use in face recognition.

b. Takes into consideration the width of the nose.

b. Length of the nose

i. The length of the nose might vary from person to person and hence adds up to an essential feature that could be used to differentiate between human faces

1. Related works:

a. takes into consideration the vertical position of the nose

c. The nose tip

i. The height of the nose is also a property that generally varies from person to person and hence even this feature could be used to create an ideal system to recognize faces

d. Nostrils

i. As we had stated above the nose can also be characterized by two dark region that represents nostrils, hence it is quite obvious that if these dark region is identified then the precise location of the nose can also be determined.

1. Related works:
    a. Detects the nostrils of the nose in a cluttered image.

Other works:

- Has used the viola jones algorithm to determine the human face. Firstly, the face is detected using which a facial recognition system has been implemented. The nose has been detected as a whole and then its corresponding histogram is generated which is used along with the other points for facial recognition.
- Takes into consideration the nose as a facial feature and uses it for facial detection. The proposed system obtains a face bounding box in the nose region.

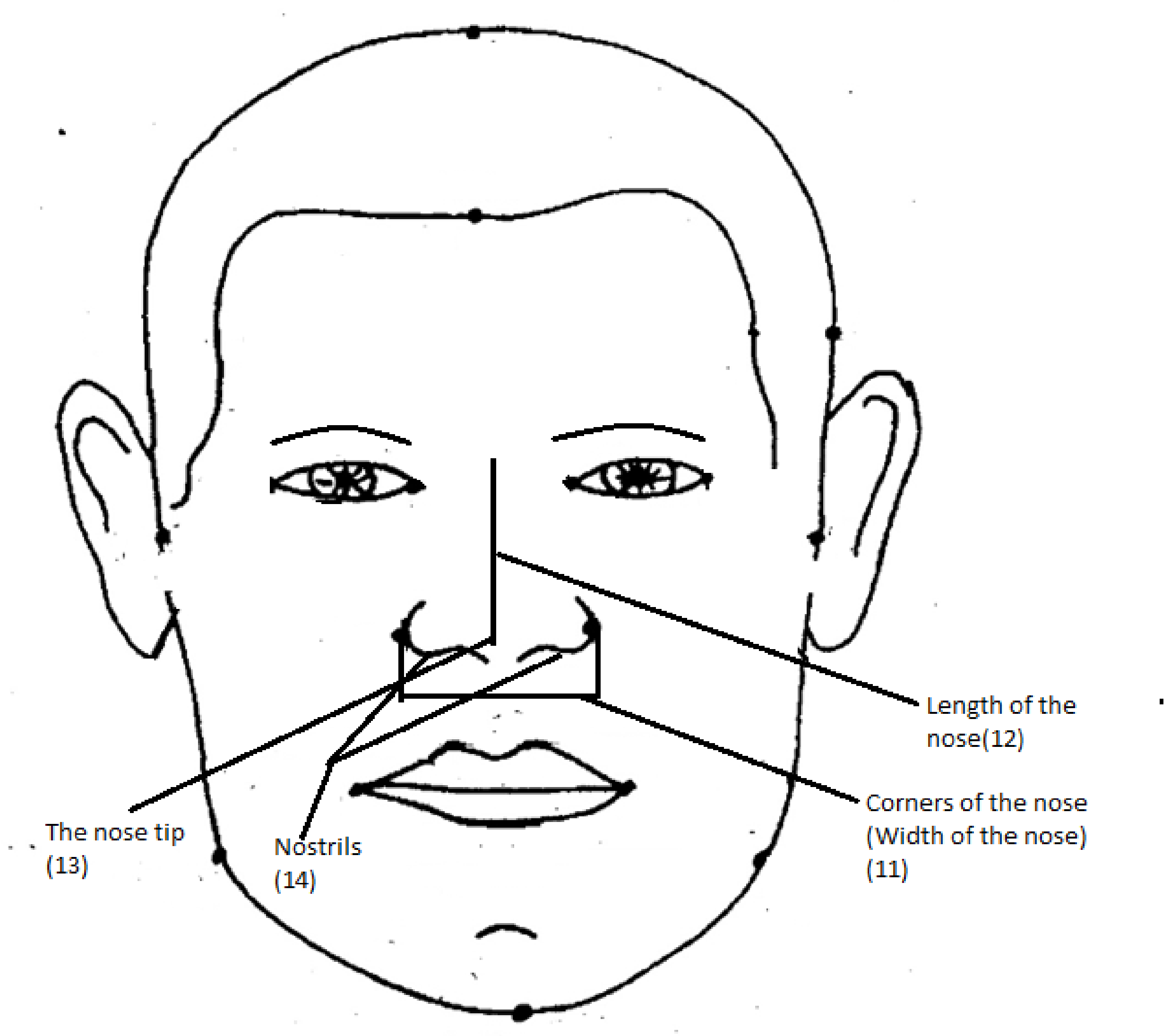


Fig: Figure representing the details of the nose

Nose detection using Viola-Jones algorithm:

This approach to detecting objects combines four key concepts: 1. Simple rectangular features, called Haar-like features. 2. Integral image for rapid features detection 3. AdaBoost machine-learning method 4. Cascade classifier to combine many features efficiently

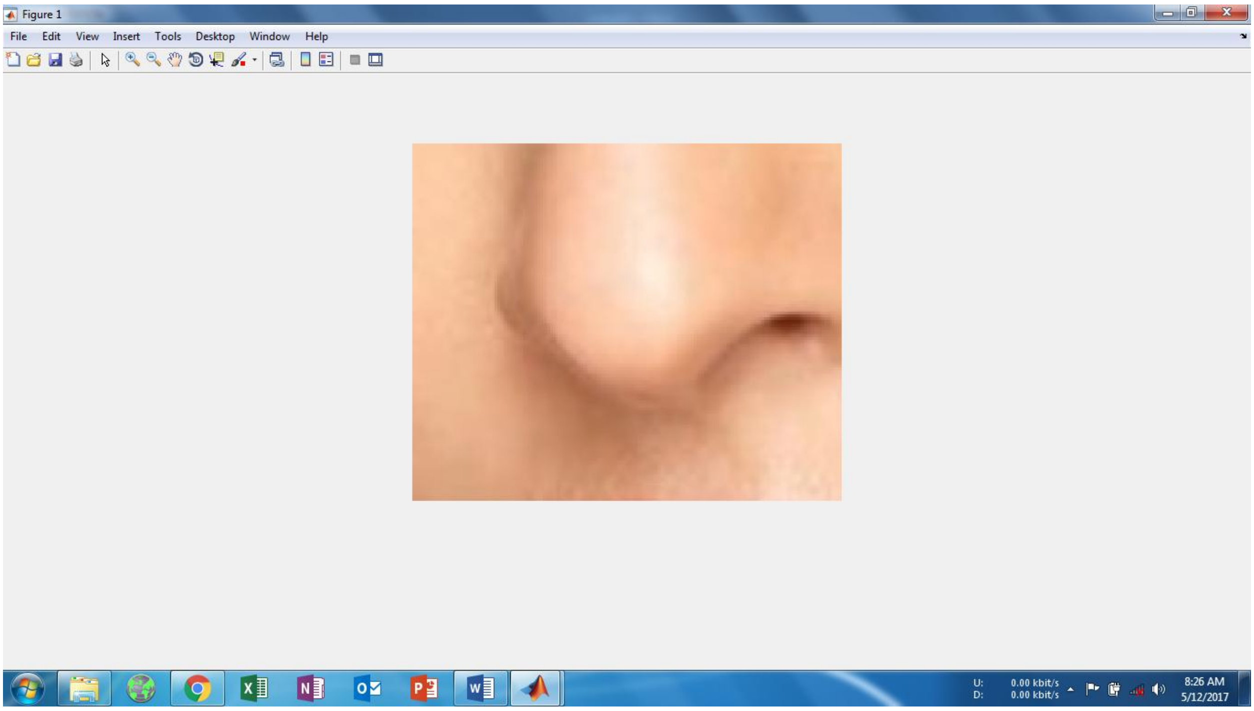
A. Haar like features are used to detect variation in the black and light portion of the image. This computation forms a single rectangle around the detected face. Based on the color shade near nose or forehead a contour is formed. Some commonly used Haar features are: 1. Two rectangle feature. 2. Three rectangle feature. 3. Four rectangle feature. The value of two rectangle feature is the difference between the sums of the pixels within two rectangle regions . In three rectangles, the value is center rectangle subtracted by the addition of the two surrounding rectangles. Whereas four rectangle features computes the difference between the diagonal pairs of the rectangles

B. Integral Images They are also known as summed area tables. Integral image is used to felicitate quick feature detection. The meaning of integral image is the outline of the pixel values in the original images. The integral image at location (x,y) contains the sum of the pixels above and to the left of (x ,y) inclusive

$$II(x,y)=\sum_{X'<=X,Y'<=Y} i(x,y)$$

C. Adaboost machine learning method uses an important concept of Bagging that is procedure for combining different classifiers constructed using the same data set.It is an acronym for bootstrap aggregating, a motivation of combining classifiers is to improve an unstable classifier and an unstable classifier is one where a small change in the learning set/classification parameters produces a large change in the classifier.AdaBoost algorithm helps to select small features from the face that facilitates fast and easy computation .Unlike other methods, AdaBoost algorithm gives desired region of the object discarding unnecessary background. AdaBoost learning process is fast and gives more number of desired data. This data can be classified into classifier. A classifier contains small features the face. It is commonly employed for pattern detection.This method has high accuracy and detection speed with about 1% false detection but requires more time to train.

original image

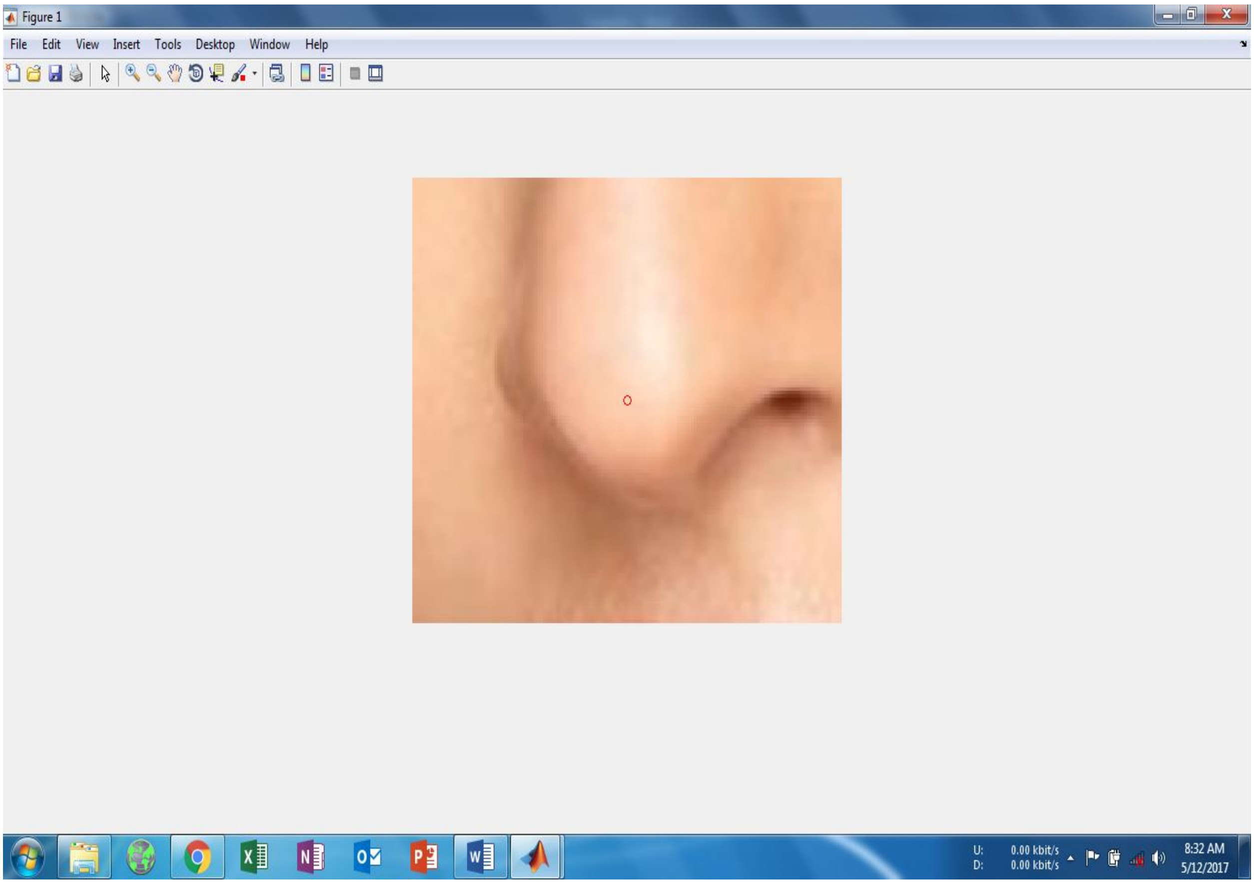


Nose cropped using Viola jones algorithm

Finding the nose tip

After cropping the nose we need to find the nose tip.For that we need to find the centroid of the cropped image.This is achieved by converting the RGB image to grayscale and using the method regionprops() based on a specified label.

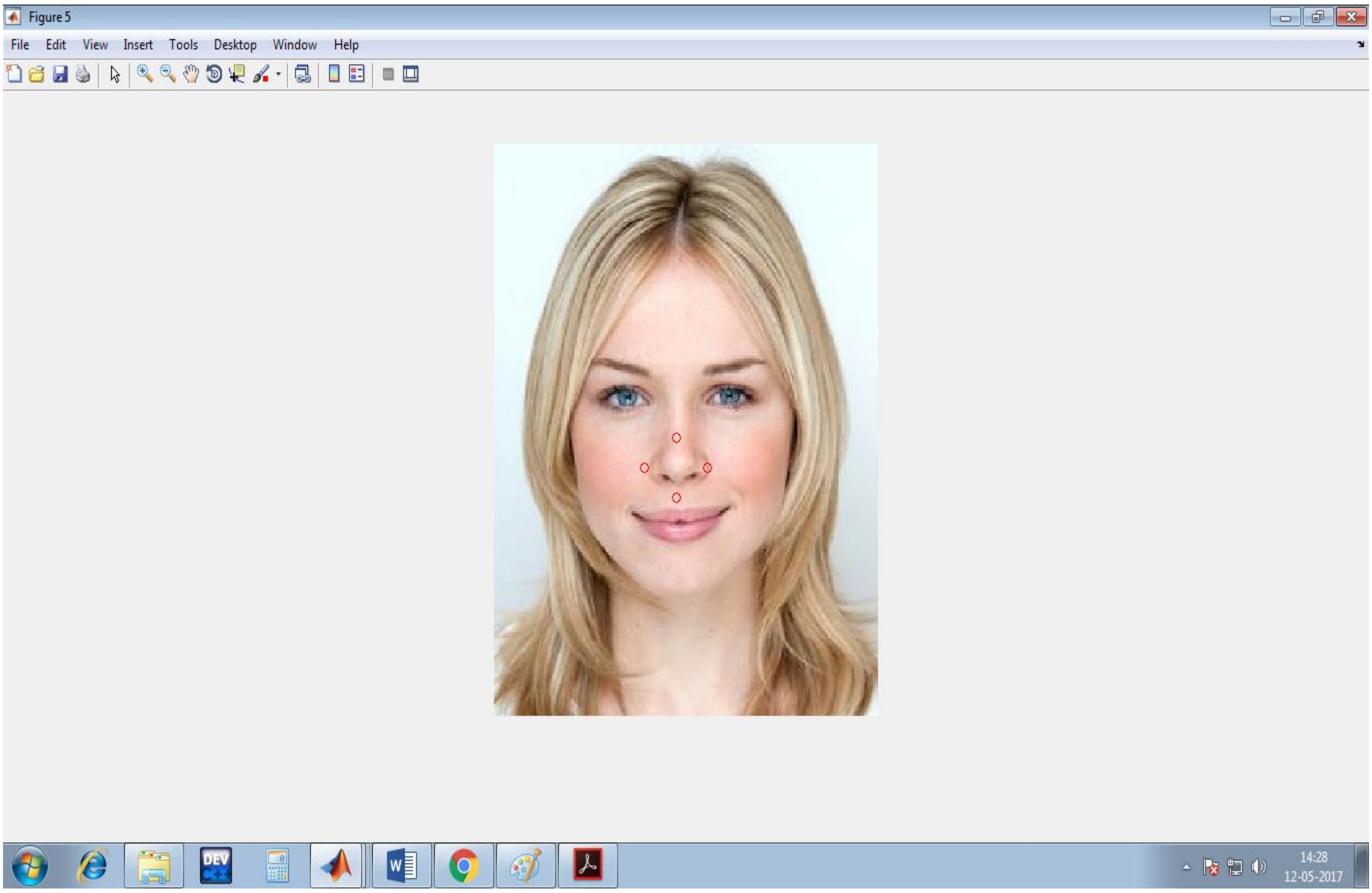
```
Ibw = im2bw(nose);
Ibw = imfill(Ibw,'holes');
Ilabel = bwlabel(Ibw);
stat = regionprops(Ilabel,'centroid');
imshow(nose);hold on;
for x = 1: numel(stat)
plot(stat(x).Centroid(1),stat(x).Centroid(2),'r
o');
end
```



Nose tip as represented by the red dot

Detection of ends of the nose

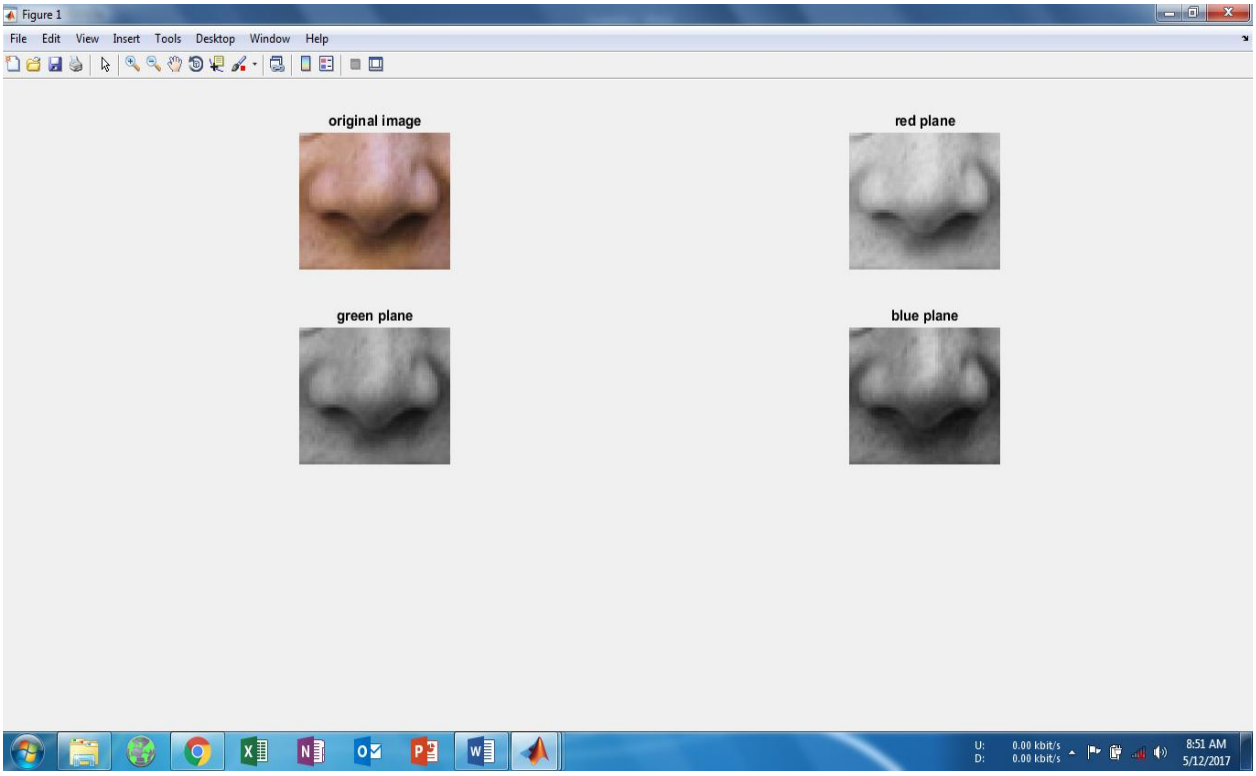
To detect the ends of the nose we have used the BB box of the Viola-jones algorithm.the BB box consists of the (X,Y) coordinates of the topmost left corner and the length and the width.The box consists of the cropped nose.so by some mathematical calculations we can easily determine the end points of the nose.



Detection of end points of nose as represented by red circles

Segmentation

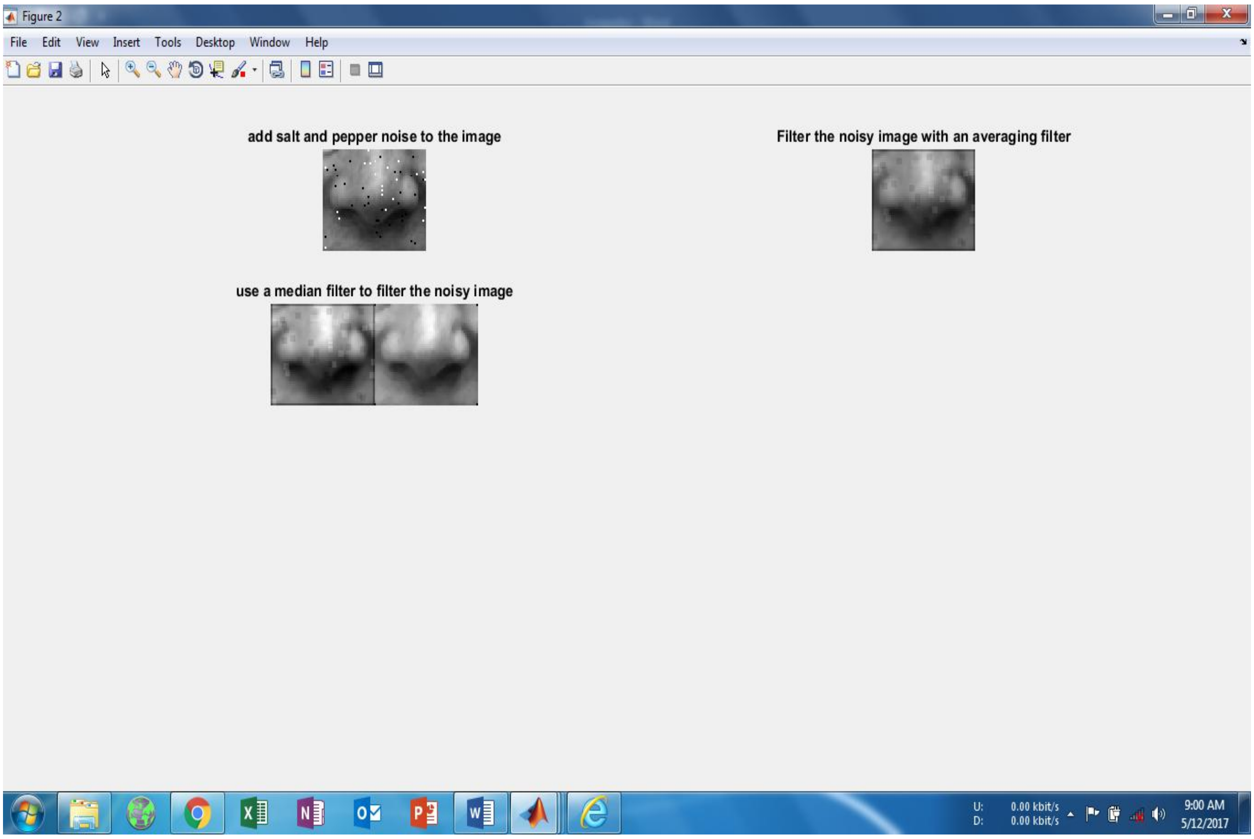
The first step taken is to divide the image into three images based on the intensities of each red, green and blue component within the image. This is Color Based Image Segmentation. The blue plane is the best choice to use for Image Thresholding because it provides the most contrast between the desired object (foreground) and the background. Image Thresholding takes an intensity image and converts it into a binary image based on the level desired. A value between 0 and 1 determines which pixels (based on their value) will be set to a 1 (white) or 0 (black)).



Division of the image into three images based on the intensities of each red, green and blue component within the image

Noise removal

Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, depending on how the image is created. Here we show how to remove salt and pepper noise from an image using an averaging filter and a median filter to allow comparison of the results. These two types of filtering both set the value of the output pixel to the average of the pixel values in the neighborhood around the corresponding input pixel. However, with median filtering, the value of an output pixel is determined by the median of the neighborhood pixels, rather than the mean. The median is much less sensitive than the mean to extreme values (called outliers). Median filtering is therefore better able to remove these outliers without reducing the sharpness of the image.



Removal of noise

Edge detection

The operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives – one for horizontal changes, and one for vertical. If we define **A** as the source image, and $\mathbf{G}_x$ and $\mathbf{G}_y$ are two images which at each point contain the horizontal and vertical derivative approximations respectively, the computations are as follows:[2]

-1	0	+1
-2	0	+2
-1	0	+1

Gx

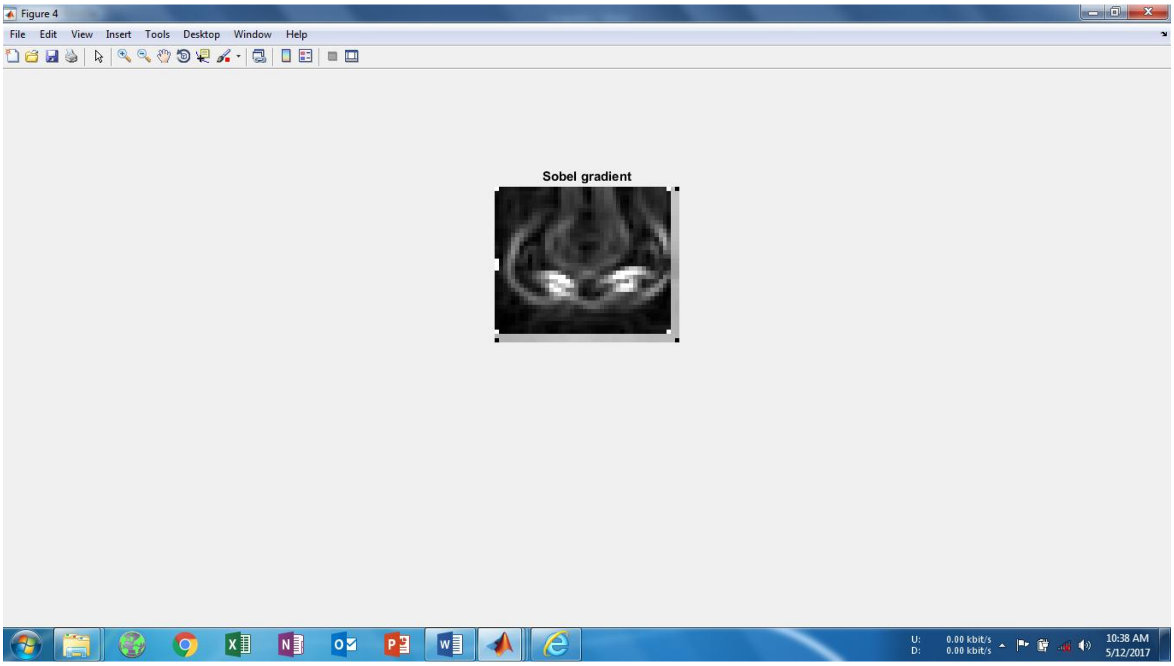
+1	+2	+1
0	0	0
-1	-2	-1

Gy

Since the Sobel kernels can be decomposed as the products of an averaging and a differentiation kernel, they compute the gradient with smoothing.

The *x*-coordinate is defined here as increasing in the "right"-direction, and the *y*-coordinate is defined as increasing in the "down"-direction. At each point in the image, the resulting gradient approximations can be combined to give the gradient magnitude, using:

$$Gx = \sqrt{\ }\,(Gx^\wedge 2 + Gy^\wedge 2)$$

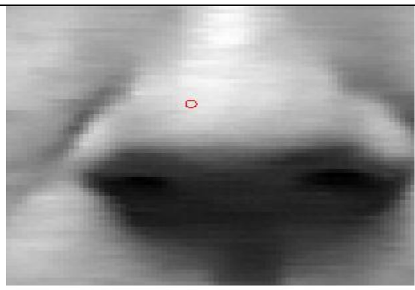
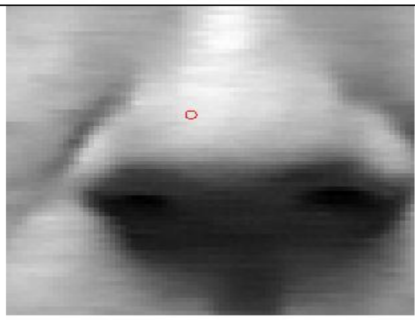
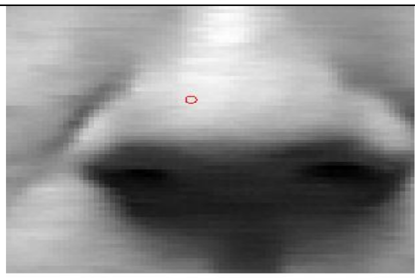
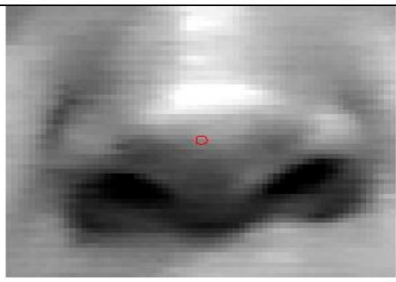


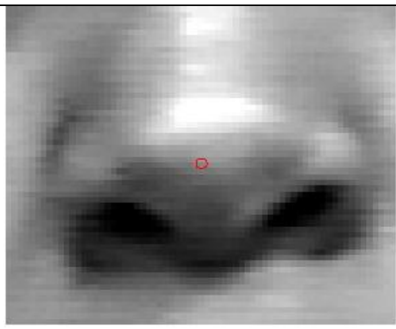
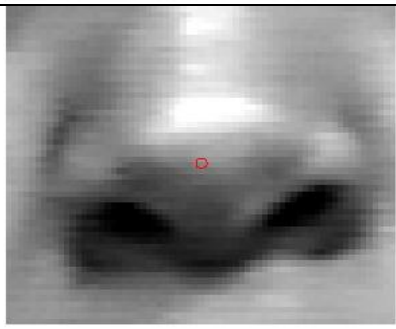
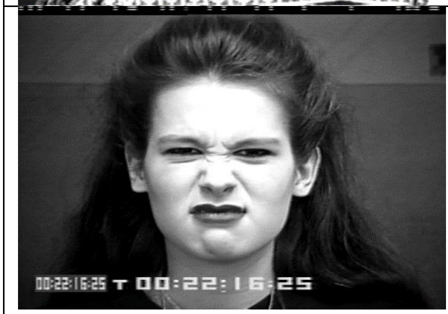
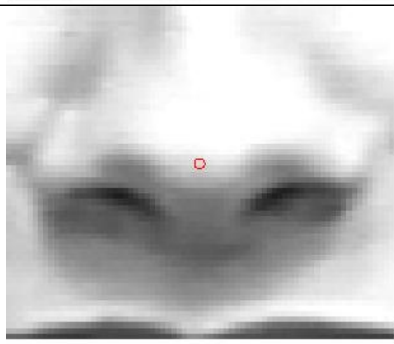
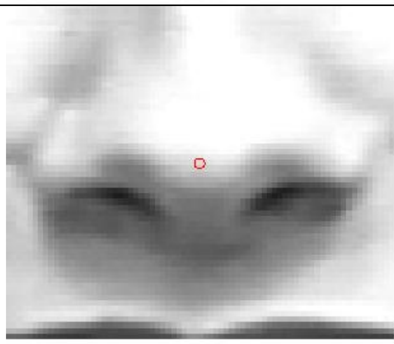
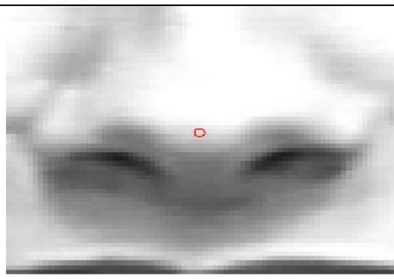
Finding the nose width and height

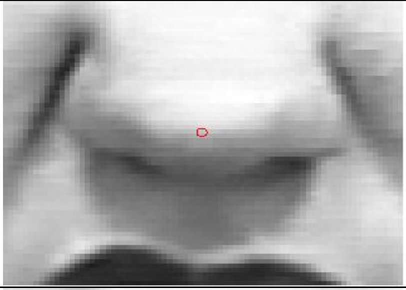
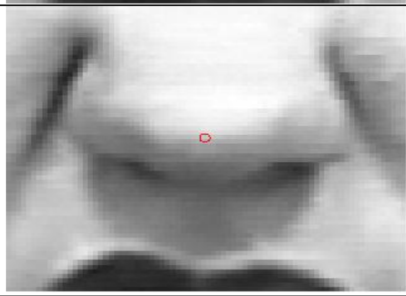
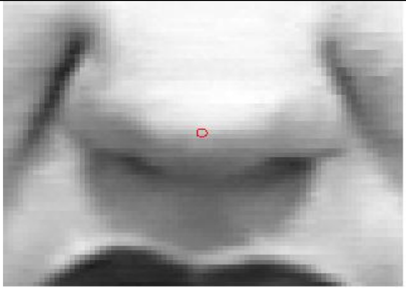
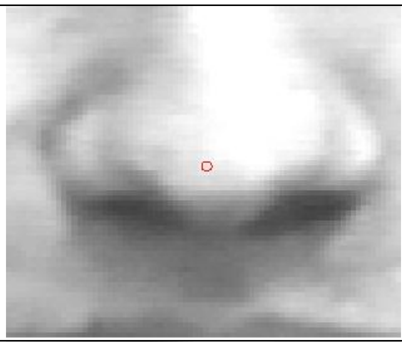
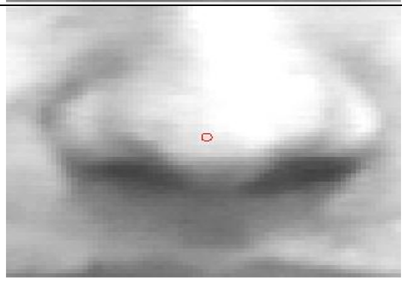
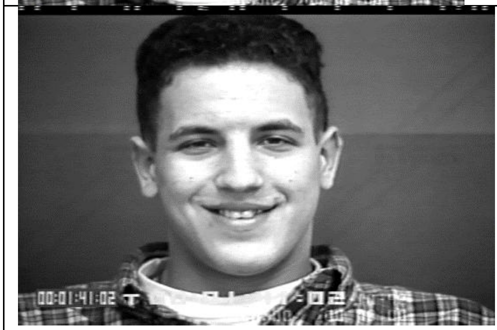
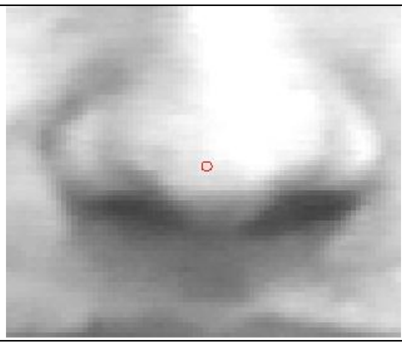
```
[r1,c1] = find(Kmedian);
x2 = max(r1);
x1 = min(r1);
X = x2 - x1
y2 = max(c1);
y1 = min(c1);
Y = y2 - y1
calib=21/2200;
xdist=X*calib;
ydist=Y*calib;
disp(xdist)
disp(ydist)
```

`[i,j] = find(X)` returns the row and column indices of the nonzero entries in the matrix `X`. Then we find the max row index of the pixel with nonzero value and we find the minimum row index with nonzero value.Substraction gives us the nose width in pixels.the same also applies for columns with nonzero value.To convert the pixel distances to inch we have used an appropriate calibration.

Results

Image (angry,sad,simle)	Nose width and Height(inch)	Nose tip
	0.7350 0.8782	
	0.6873 0.8209	
	0.7064 0.8495	
	0.5250 0.6300	

	0.5250 0.6300	
	0.5536 0.6586	
	0.6109 0.7350	
	0.5823 0.6968	
	0.6727 0.7873	

	0.6109 0.7350	
	0.5823 0.6968	
	0.6023 0.7105	
	0.6109 0.7350	
	0.6025 0.7236	
	0.6300 0.7445	

Conclusion

- In this experiment,we have detected the nose using Viola-jones algorithm
- We have used color based Image Segmentation. We have divided the image into three images based on the intensities of each red, green and blue component within the image. The blue plane is the best choice to use for Image Thresholding because it provides the most contrast between the desired object (foreground) and the background.
- We have used Salt and Pepper noise and average and median filtering to remove the noise.
- Finally after edge detection using Sobel we have detected the width and the height using find(),max()and min().
- Finally, we have applied our code on a set of faces and the corresponding results have been listed in a table. For angry and smiling faces, we have seen that the nose width got enlarged and the nose height changes proportionally.

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