Face Shape Classification Based on Region Similarity, Correlation and Fractal Dimensions

N K Bansode [1], P K Sinha [2]
[1] Department of Computer & IT, College of Engineering , Pune University of Pune, India
[2] Department of Computer & IT, College of Engineering , Pune University of Pune, India

Abstract

In this paper, we have presented a new idea for face shape classification based on the three techniques such as facial region similarity, correlation and fractal dimensions. The human face is described by different semantic attributes like shape, color and texture. The semantic description of the object attributes helps in searching the object by its contents. The face shape similarity is described with the semantic attribute of the shape like a circle, ellipse, triangular, rectangular or oval, etc. The searching face image using semantic description is potentially important for the law enforcement agencies. The face shape is approximated by using degree of the fitness of the face shape with the geometrical shapes. The result shows that, the proposed approach based on the facial region matching gives effective results for face shape classification.

Keywords: *Face Shape Classification, Region Similarity, Set Operations, Correlation, Fractal dimensions.*

1. Introduction

The automatic processing of the object requires detection and recognition of the object by the computer systems. The object in the real world is three dimensional and it is represented as image in two dimensions. The two dimensional object is described according to the object properties like shape of the object, color and texture. Many other properties of the objects are represented from simple to complex computational expensive methods such as global and local. The global shape measure describes the shape of the object by simple scalar value such as shape measure of the circularity or elongation. The Haralicks measure of the circularity is also used for the measurement of the object shape. The Haralicks circularity measurement is considered as the best measurement for the polygon circularity. The shape descriptor such as moments, Fourier descriptors and auto regression represents the shape as global measurement [9].

The shape of the object describes the object's geometric structure and appearance. The object shape makes it different from the other objects. The human face shape is more complex compare to the other objects shapes. The human faces vary in shapes and size due to changes in external or internal parameters. The complexity of the face shape increases due to variation with respect to age and expressions. For the identification of the person, the face shape plays a very important role. The face processing applications include face recognition, tracking, verification and validation. Due to advanced digital technology, many devices are able to capture and store the images. The large number of images and videos are also available on the internet or in the digital space. To search a particular object using the object's attributes is a challenging problem for the fast and accurate image retrieval**.** The searching object with attributes is known as semantic search or search by contents which finds the image from its contents or description. The human face is complex and processing of the face image for face shape classification is challenging due to the variations in the size, rotation, illumination. The face occlusion due to the external objects like glasses or hat also presents a problem for the face processing. The object's shape is important for the detection and recognition of object for automatic processing in the computer vision and robotic application. In the medical applications, shape of the different organs in the normal or abnormal form used for medical decisions. In the industrial application detection and processing of the different objects by the machine vision plays very important role in the industrial automation.

2 Shape Representations

Geometrically shape is presented as a fixed number of the points on the boundary of the object. The points on the each object boundary represent the approximate object shape. The shape is an object property which has been carefully observed and studied for the different types of the applications. The object shape processing involves recognition, automatic inspections and technical diagnosis. The objects are represented with the different shapes. The problems with object shape description and processing is that, the object scale and change in resolution results in the modification of the shape. A shape space approach has been presented that aims to obtain continues shape description. In many cases it is important to obtain shape class. The shape classes represent the general category of the object. The current research in the object shape study includes the development of new methods to automate understanding of object shape and reliable definition of shape classes. The object's shape is described or represented with the different methods based on the region and boundary of the objects. These methods are described in the following sections.

2.1 Region Based Shape Descriptors

In this process of the object processing, the object is split into different separate, unique regions based on the region similarity and each region is assigned unique identification number. For the region identification, adjacent similar regions are combined together using four connected or eight connected components. If the non-overlapping ordered numerical labels are used for the identification of the region, then the larger region is assigned with the largest integer number [10]. The object's shape can be generated and calculated by geometric area properties like height, width, Euler's number, rectangularity, directions and compactness. The statistical moments represent as a probability density of a two dimensional random variable. The moment shape descriptor gives a value which is invariant to the scale and rotation. The shape can be also described using region decomposition into smaller simple sub region resulting from region decomposition.

2.2 Contour Based Shape Descriptors

In contour based shape description, objects shape is represented by the object's boundary. The boundary based methods included chain codes which represent the shape by smaller segments and the direction of the each segment that gives the shape representation called as Freeman chain codes. The object outline can be described by the properties like object boundary length, curvature of the shape, bending energy around the object, signature and chord distribution for shape**.** In the contour based shape representation, the object boundary is represented by landmark points.

A landmark is an identifiable point on the object that corresponds to matching points on similar objects. The landmark points represent the object boundary and classified into the following types**.** Anatomical landmarks: These points on the boundary of the objects.

Mathematical landmarks: In this type of the landmarks, the points located on the object outline according to the some mathematical expressions or shape geometry.

Pseudo landmarks: These are constructed points on the object's boundary or between landmarks.

The Point distribution model (PDM) is a useful shape description technique for the object that may subsequently be used in locating new instance of such shapes in other images [10]. The PDM represents the shape that a human can understand or describe easily.

The PDM is based on the set of M data points called as training data or a training set from which a statistical property of the variations and shape information is derived**.** The point distribution model assumes that the all the points are on the boundary of the objects. These boundary points called as landmark points. The points on the boundary of the object are represented by the x and y coordinates of the points. These boundary points represent the shape of the object under consideration. The PDM is designed by selecting the landmark points in all the objects of the training set.

The training set consists of the object of the same category as well as size [10]. In order to work the PDM model properly, the alignment of all these boundary points to certain fix point is necessary. The images in the training set are aligned to the one of the face image is denoted as mean shape. The other images in the training are aligned by translation, scaling and rotation. The variation in each image from the mean shape is calculated by checking the difference of the images from the mean shape of the training.

3 Related Work

The shape of the object is very useful for automatic detection and identification of the different objects. The shape is an important object property description for classification of the objects. The various studies are performed for the description of the shape and measurements. There are different applications based on the shape of the objects in the design as well as automatic handling of the objects. One of the most measurements of the shape is the circularity of the shape.

Ana M. Herrera-Navarro et al[1] used chord distribution method for the measurement of the circularity of the objects. The method is based on the probability distribution of the radius. Raul S. Montero[7] described state of art method in the shape description based on the compactness and the circularity of the shape. The compactness is measured based on inner distance, reference shape and geometrical pixel property approach. Celina Maki Takemura et al [2] presented shape classification based on the polygonal wavelet transform for the landmark representation. The landmark representation used for the time signal representation. Milos Stojmenovie and Amiya Nayak [6] explored the circularity measurement for the planar point sets. The circularity of the ordered and unordered data points is measured based on the linearity measurements. The algorithm designed for open and closed curves. Haibin Ling [4] proposed inner- distance based method for the shape classification. Three different methods are used for shape description and classification, like inner-distance and multi scaling, shape context and texture information based on the shortest path. Tim Cootes [8] described the model for the different objects based on the boundary structure of the object. The shape of the biological organs and the human face shapes are successfully modeled based on the boundary landmark points and model is designed to represent variations in the object shapes called as active shape model. Zhang Qian [5] et al used active shape model algorithm and k-nearest neighbor algorithm for the face shape classification using the hausdroff distance measurement. Luning. Li et al [3] presented active appearance model based face shape classification. The support vector machine with multi classifier is used for the classification of the three face shape such as lemon shape, round or square shape. The face classification is used for the expression recognition. Kamal Nasreddine et. al [13] explored method for the various shape matching for the purpose of object retrieval and shape classification. The methods are based on the multi scale distance for global and local shape variations. The shape measurement is invariant to the translation, scaling and rotation.

4 Methodology

The object shape classification is finding many applications in industry for automatic processing and robotic applications. The automatic detection of the object requires object recognition either based on the shape or color. In this study, we have presented a new method for the face shape classification based on the degree of similarity of the face shape with standard geometric shapes. The face shape is approximated to the closest geometric shape. The face shape can be classified into different classes such as round, elliptical, rectangle, oval and triangular**.** The figure 3 shows different types of the human face shapes[17]. The human face is three dimensional objects in the real world space**.** The three dimensional shape can be projected into two dimensional by the different projections. The human face is complex object due to the degree of the freedom and variations in the size. The front face images are considered for the implementation in the present work of the face shape classification. The method for shape classification consists of fitting geometric objects like an ellipse, circle, rectangle, triangle and oval on the region of the human face and finding the best fitting geometric object which gives minimum error. When the two shapes are similar, the process of finding common regions is the fitting one shape over the other. In this case the two shapes perfectly fit with one another and error in the common region of the two shapes almost zero. When the two objects of the different shapes are fitted together by overlapping one another and error is measured which gives the variation in the regions or the measurement of the error of fitting the two objects. The face shape is classified by detecting the face in the image. The preprocessing of the face image is performed for the separating the facial region from the background image. The facial region is separated from the face image using Viola-Jone method for detecting faces and extracting the face from image [11]. The concept of the similar region or common area between two objects as well as non-similar regions between two objects are used for finding the similarity of the objects. The set theory is used in finding the degree of similarity of the face image with the geometrical objects like a circle, ellipse, triangle, etc. The digital face image is represented as a function of two dimensional cartesian coordinate system and intensity values**.** Thus image I is represented as a function of the intensity values as f(x, y). Let Z be the set of the real integers. The image f(x, y) is made of set integers from the set Z and f is the mapping function that assigns the intensity value to each distinct pair of the coordinates (x, y). A digital image becomes a two dimensional function whose coordinates and intensity values are integers.

Let A be a set in a Z, the elements of which are pixel coordinates (x ,y). If w=(x, y) is an element of A, then we write w $\in A$, similarly if w is not a member of the A we write $w \notin A$.The union of the sets A and B given by $c = A \cup B$ and similarly, the intersection of the two sets is given by $c = A \cap B$ that is the set of elements common to the both the sets A and B. The difference of set A and B is given by A-B is the set of all the elements that are belong to A but not to the set B $A - B = \{ w | w \epsilon A, w \notin B\}$

The face shape classification problem is presented in the current research paper and classification of the shape is preformed by the three different methods such as region similarity, correlation coefficient and fractal dimensions. The details of the face shape classification are described in the following sections.

4.1 Region Similarity Method

The application of the set theory is used to compute the measurement of the similarity of the face region with the geometric objects. The figure 1(a) shows the square and figure 1(b) shows ellipse objects**.** When the two objects the same shape are fitted or overlapped together, then the error of the measurement is zero. When the two objects are of different shapes are fitted or overlapped together, then the degree of the fitness measurement is to minimize the error between the two shapes. The fitness measurement of the region of the image is performed by the fitting the geometrical objects on the other object of similar or different types [15]. The figure. 1 (c) shows the common region between the square and the ellipse when the square and ellipse are fitted together. The matching region or area is given by the set operations as region common to the both the shapes as shown in figure 1 (c). This matching area is calculated by the counting the number of pixels which are common in the square and ellipse. This pixel count is called as common region or matching region.

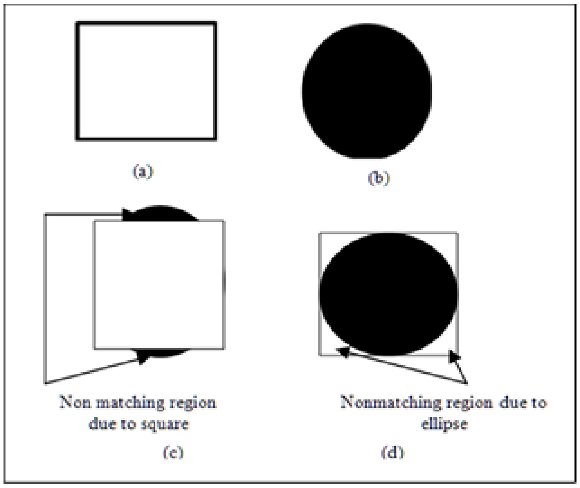

Fig. 1 Object Region (a) Square (b) Ellipse (c) Non Matching area due to Square (d) Non matching area due to Ellipse

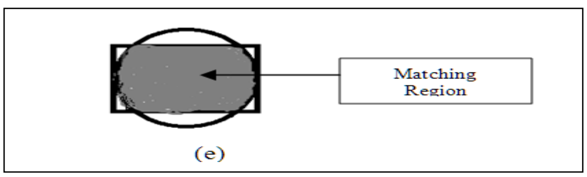

Fig. 2 Matching Region in Square and Ellipse

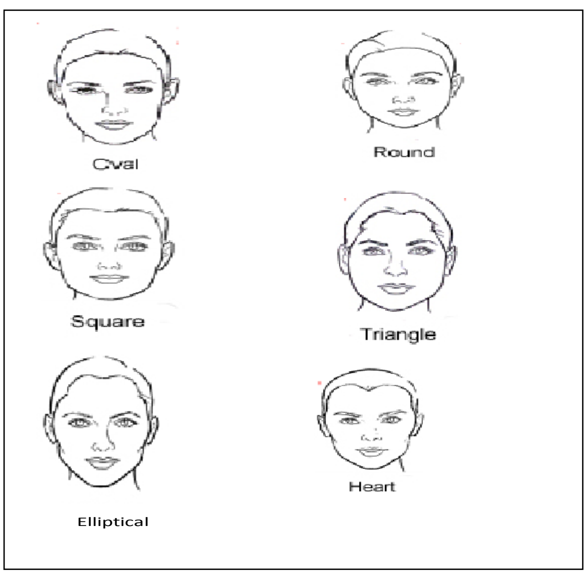

Fig 3. Face shapes

The matching region between square and ellipse is given by Matching Region = (Square ∩ Ellipse) as shown in figure 2. The next step is to find the non-matching regions.

There are two types of the non-matching regions, first due to square fitting over the ellipse as shown in figure 1 (c) and second due to ellipse fitting over the square as shown in figure 1 (d). The Non matching region due to square is Square-(Square ∩ Ellipse) and Non matching region due to the ellipse is
Ellipse-(Ellipse ∩ Square).
The total non-matching region is given by

$$NonMatching\ Region = (Square - (Square \cap Ellipse)) + (Ellipse - (Ellipse \cap Square))$$

$$= (Square - (Square \cap Ellipse)) \cup (Ellipse - (Ellipse \cap Square))$$
$$= (Square \cup Ellipse) - (Ellipse \cap Square) \quad (1)$$

The degree of the fitness of the Square with the Ellipse is

$$Fitness\ degree = \frac{Nonmatching\ region\ of\ square\ \&\ ellipse}{Matching\ region\ of\ square\ \&\ ellipse} \quad (2)$$

$$Fitness(Square, Ellipse) = \frac{(Square \cup Ellipse) - (Ellipse \cap Square)}{(Square \cap Ellipse)} \quad (3)$$

Algorithm: Face Region Similarity (Face Images)

1 Read the face dataset D (i=1.2……n) and image I (x ,y)
  For i=1 to Number of images do
    Read image I, convert to Gray Scale
    Find the face region using face detection
    End
2 For i=1 to number of images do

$$Circle(degree) = \frac{((Face \cup Circle) - (Face \cap Circle))}{(Face \cap Circle)} \quad (4)$$

$$Ellipse(degree) = \frac{((Face \cup Ellipse) - (Face \cap Ellipse))}{(Face \cap Ellipse)} \quad (5)$$

$$Rectangle(degree) = \frac{((Face \cup Rectangle) - (Face \cap Rectangle))}{(Face \cap Rectangle)} \quad (6)$$

$$Triangle(degree) = \frac{((Face \cup Triangle) - (Face \cap Triangle))}{(Face \cap Triangle)} \quad (7)$$

$$Oval(degree) = \frac{((Face \cup Oval) - (Face \cap Oval))}{(Face \cap Oval)} \quad (8)$$

3 Face Similarity = min{Circle(degree), Ellipse(degree), Rectangle(degree), Triangle (degree), Oval(degree) }
4. End.

The face shape classification based on region similarity is implemented and the result is shown in table 1.

4.2 Correlation Method

In this method of the face shape classification, the correlation coefficient (r) of the face image with the standard geometric objects like ellipse, circle, oval and rectangle is calculated using the Eq. (9). This correlation coefficient gives the measure of how the face image shape is more correlated with the different geometric objects. The maximum correlation coefficient value between the face image and geometric shape represents the approximation to the face shape.

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \quad (9)$$

where $\bar{A}$ = mean2 (A) , and $\bar{B}$ = mean2 (B) . .

A_{mn} and B_{mn} represent the image in the matrix form or in the vector form. The correlation coefficient of the face image and standard geometric objects is calculated. The result of the face shape correlation is shown in table 2.

4.3 Fractal Dimensions Method

The fractal dimensions are used to measure the complexity of the objects. The fractals based features are used to classify the image texture. The classical geometry has the integer, dimensions for example line has dimension of 1, square has dimensions of 2 and cube has dimension of the 3 while the fractal dimension may be having fractional dimension. For the gray level image, it can be considered as 3D surface with x, y values represent the coordinates and gray value or intensity of the pixel represents the z value in the 3D representation. The fractal dimension is implemented using box counting techniques. The box counting methods involve the covering the object with smaller boxes of the size ϵ and counting the number of the boxes required to cover the objects. The number of boxes required varies with the scale of the box. If we select a large box size then a small number of the total number of boxes (N) required on the other hand, if we select the larger box size small number of boxes are required to covet the image object. The size of the box and the number of boxes required is specified by the relation.

$N \propto 1/s$ where N – total number of boxes and s – scale of the box.

The fractal dimension of the object is given by

$$d = \lim_{\epsilon \to 0} \frac{\log N(\epsilon)}{\log(\frac{1}{\epsilon})} \quad (10)$$

When we plot the least square line fit the curve of the different scales of the box and the different dimension d. The slope of the curve gives the fractal dimension of the object. In order to classify the face shape the fractal dimension of the face and the geometric object are calculated. The difference of the face fractal dimension and geometric object fractal dimension is calculated. The minimum difference between the face and geometric shape represents the best approximation to the face shape. The result of the face shape classification using fractal dimension in shown in table 3.

5 Results and Discussions

In this paper, we have implemented classification of the face shape based on the three different methods such as facial region similarity, correlation coefficient and fractal dimensions. The similarity of the face is compared with geometric objects such as circle, ellipse, rectangle, triangle and oval, etc. The face shape similarity is calculated based on the degree of the similarity with the geometric objects. The experiment of the faces shape classification implemented using three face datasets such as Caltech with 450 faces, Cuhk with 260 faces and Lfw with 200 faces. The sample results of the face shape classification based on the three methods are shown in Tables 1,2 and 3.

Table 1: Region Similarity Results

Sr No	Ellipse	Rectangle	Circle	Triangle	Oval	Remark
1	0.276336	1.596545	0.397840	6.020438	13.455792	Ellipse
2	0.202000	1.437648	0.298430	8.161528	32.714876	Ellipse
3	0.297332	1.655375	0.327388	4.226830	10.123960	Ellipse
4	0.326392	1.687431	0.343421	3.644118	7.160209	Ellipse
5	0.062356	1.363296	0.181387	7.618260	22.067449	Ellipse
6	0.155414	1.410472	0.204960	6.623011	19.100068	Ellipse
7	0.336958	1.797504	0.398459	3.501718	7.592896	Ellipse
8	0.294139	1.687728	0.343408	4.696415	12.125286	Ellipse
9	0.334029	1.781883	0.390642	3.378611	6.804146	Ellipse
10	0.259174	1.684825	0.342125	4.071129	9.091145	Ellipse
11	0.288318	1.895917	0.447634	3.064228	6.451255	Ellipse
12	0.257048	1.828262	0.413822	3.473395	7.239148	Ellipse
13	0.298303	1.692390	0.345920	3.480819	6.528218	Ellipse
14	0.246671	1.666100	0.332766	3.708696	8.116324	Ellipse
15	0.151690	1.460796	0.230011	7.869727	28.158155	Ellipse
16	0.170686	1.325328	0.162337	7.363004	15.445037	Circle
17	0.638883	2.444492	0.721691	1.894658	2.484321	Ellipse
18	3.532461	8.158872	3.577863	0.653730	0.562415	Oval
19	0.313285	1.477971	0.238559	5.771239	8.911629	Circle
20	0.478129	1.831191	0.415159	3.509986	5.508552	Circle

Table 2: Correlation Coefficient Results

Sr. No	Ellipse	Triangle	Oval	Circle	Rectangle	Remark
1	0.323955	0.074207	0.074154	-0.297563	-0.637371	Ellipse
2	0.201170	0.090122	0.085334	-0.246019	-0.538781	Ellipse
3	-0.047806	-0.010159	-0.010007	0.014681	-0.267600	Circle
4	-0.009241	0.023786	0.019690	0.037643	-0.053059	Circle
5	0.010407	0.000214	-0.000310	-0.001716	-0.153877	Ellipse
6	-0.012442	0.011566	0.009997	0.023583	-0.281422	Circle
7	0.004567	0.004176	0.002245	-0.029503	-0.311692	Ellipse
8	0.001250	0.014865	0.017449	0.022128	-0.108651	Circle
9	0.002502	-0.011816	-0.019509	-0.000335	-0.221567	Ellipse
10	0.031854	-0.030845	-0.031349	-0.096258	-0.292229	Ellipse
11	0.136196	0.005622	0.003328	-0.061024	-0.362611	Ellipse
12	0.146149	-0.003213	-0.001324	-0.069544	-0.283270	Ellipse
13	0.373087	0.078749	0.076508	-0.293642	-0.691137	Ellipse
14	0.075687	0.009222	0.010038	-0.015771	-0.201524	Ellipse
15	0.085996	0.011719	0.005689	-0.033992	-0.306589	Ellipse
16	0.046721	0.009975	0.004540	0.006125	-0.275813	Ellipse
17	0.293456	0.112883	0.114627	-0.173237	-0.589126	Ellipse
18	0.194872	0.107937	0.107647	-0.104939	-0.466157	Ellipse
19	0.657909	0.139596	0.136517	-0.172325	-0.530602	Ellipse
20	0.171666	0.109853	0.107319	-0.157096	-0.539100	Ellipse

The table 3 shows sample results of the face shape classification using fractal dimensions. The fractal dimension of the face image is calculated by using Eq. (10). Similarly, the fractal dimensions of the geometric objects such as ellipse, circle, oval, rectangular and triangle are also calculated using Eq. (10). The face shape is classified using the minimum difference of the fractal dimension between the face and the geometric shape. The shape which has a minimum difference represents the approximate shape of the face.

The face shape classification experiment is implemented using Caltech face data set with 450 faces. The result of the face shape classification using three methods is shown in table 4. The numbers in the tables indicate that number of faces which are classified as into the different shapes. The result shows that more number of the (86.22%) faces are of the ellipse type. The figure 4 shows the graph of the different face shape in the dataset. The graph shows that all three methods of the face shape classification indicate the maximum number of the faces of the ellipse type than circle, oval, triangular and rectangular.

The tables 5 shows result of the face shape classification using Cuhk face dataset. The total number of 260 faces are used for the classification, the results show that the maximum number of the faces are of the ellipse type (66.16 %) in the three methods.

The figure 5 shows graphs of the face shape classification. The graph shows that there are also 22.56 % types of oval shape and (7.3%) of the circular type of the faces. The result of the face shape classification using Lfw face dataset is shown in table 6. The total 200 faces are used for the classification. The maximum number of the faces are of the ellipse type (84.16 %) by all the three methods of the shape classification. The figure 6 represents the face shape classification of the Lfw dataset.

The table 7 shows the average classification rate for the three datasets and the three methods for the face shape classification. The result shows that the on average 78.73 % ellipse, 10.23% oval, 6.63% circle, 2.63 % rectangular and 1.76 % triangular shape.

Table 3: Fractal Dimensions Results

Sr. No	Face	Ellipse	Triangle	Oval	Circle	Rectangle	Remark
1	1.337958	1.260189	1.730062	1.725379	2.008560	2.276943	Ellipse
2	1.141479	1.250492	1.730062	1.724497	2.687569	2.694950	Ellipse
3	1.274756	1.271161	1.691189	1.686686	1.848802	2.661782	Ellipse
4	1.268891	1.319001	1.731910	1.724969	2.689077	2.217286	Ellipse
5	1.309156	1.317323	1.691189	1.686547	2.491470	1.833076	Ellipse
6	1.283026	1.133276	1.691189	1.687268	2.112951	2.606925	Ellipse
7	1.276058	1.184275	1.686768	1.686720	2.478976	2.646261	Ellipse
8	1.454748	1.401347	1.729330	1.724244	2.385071	1.765042	Ellipse
9	1.310805	1.308922	1.731185	1.723634	2.580314	2.665178	Ellipse
10	1.132423	1.153206	1.691189	1.687483	2.369925	2.448929	Ellipse
11	1.360008	1.347944	1.731185	1.724180	2.474317	2.123412	Ellipse
12	1.384088	1.381652	1.730062	1.724423	2.385540	1.901249	Ellipse
13	1.244772	1.233407	1.729330	1.724584	2.435376	1.761163	Ellipse
14	1.382835	1.365189	1.729330	1.724059	2.006253	1.775501	Ellipse
15	1.278211	1.260865	1.691189	1.687055	1.788321	2.514647	Ellipse
16	1.278617	1.271809	1.691189	1.687055	2.386018	2.008289	Ellipse
17	1.208186	1.144751	1.733275	1.724598	1.171732	1.171732	Ellipse
18	1.222555	1.165424	1.732744	1.724960	1.233502	1.145986	Circle
19	1.190587	1.191509	1.729330	1.724465	2.679552	1.763776	Ellipse
20	1.209993	1.166256	1.730062	1.214334	2.168806	2.111620	Oval

Table 4: Face Shape Classification (Caltech data set)

Sr. No	Method	Ellipse	Circle	Oval	Triangle	Rectangle
1	Region Similarity	422	6	10	9	3
2	Correlation	392	34	12	7	5
3	Fractal Dimensions	350	53	35	10	2

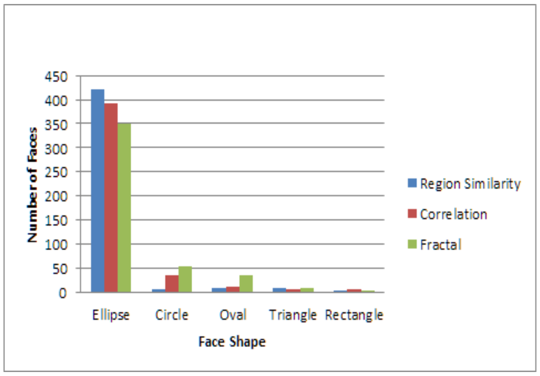

Fig 4: Face Shape classification (Caltech dataset)

Table 5: Face Shape Classification (Cuhk dataset)

Sr. No	Method	Ellipse	Circle	Oval	Triangle	Rectangle
1	Region Similarity	175	6	70	5	4
2	Correlation	172	18	55	8	7
3	Fractal Dimensions	170	25	51	8	6

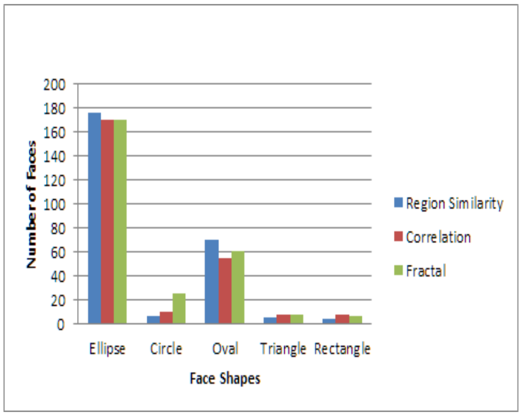

Fig 5: Face Shape classification (Cuhk dataset)

Table 6: Face Shape Classification (Lfw dataset)

Sr. No	Method	Ellipse	Circle	Oval	Triangle	Rectangle
1	Region Similarity	175	6	10	5	4
2	Correlation	170	10	5	8	7
3	Fractal Dimensions	160	15	15	8	2

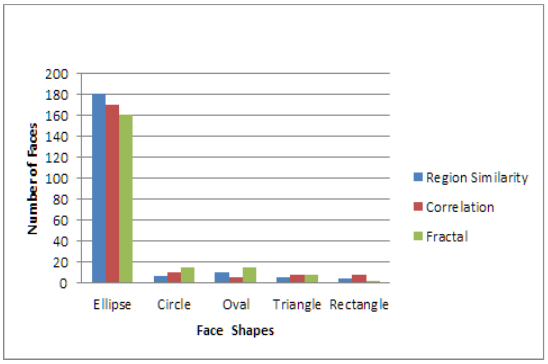

Fig 6: Face Shape classification (Lfw dataset)

Table 7: Face Shape Classification Average (%)

Sr. No	Method	Ellipse	Circle	Oval	Triangle	Rectangle
1	Region Similarity	82.41	3.75	10.3	2.14	1.4
2	Correlation	79.42	6.52	8.7	2.88	2.48
3	Fractal Dimensions	74.38	9.63	11.7	2.88	1.41

6 Conclusions

In this paper, we have presented method for face shape classification based on the three methods such as Region Similarity, Correlation Coefficient and Fractal Dimensions. The similarity of the face region is determined based on the degree of the similarity with the standard geometrical shapes. The experimental result shows that, the proposed method is effective for the classification of the face shapes.

The face shape classification algorithms developed based on the technique of the face shapes are similar to standard geometric objects like ellipse, circle, oval, triangle and rectangle. The method of the shape classification is also verified with another algorithm for classification of the face shape, i.e. the correlation of the face shape with standard geometric shapes. The third method of the fractal dimension is also implemented for the classification of the shape

The face shape classification developed with the three different face datasets. The results show that there are on average 80% faces in the three datasets with an elliptical shape. This indicates that the maximum number of the face appears as an elliptical face shape in each dataset. The rectangular and triangular types of faces are with fewer numbers. The region similarity based method of the face shape classification gives better results as compared to the correlation and the fractal dimension method.

The results show that the most effective approach is represented for the problem of the face shape classification.

The further research can be directed for the shape of the face with the geographic dimension as well as different types of the face shapes.

References

[1] Ana M. Herrera-Navarro, Hugo Jiménez Hernández. Hayde Peregrina-Barreto, Federico Manríquez- Guerrero Iván R. Terol-Villalobos, "A New Measure of Circularity Based on Distribution of the Radius", Computación y Sistemas Vol. 17 No. 4, 2013 pp. 515-526 ISSN 1405-5546

[2] Celina Maki Takemura, Roberto Marcondes Cesar Jr, "Shape Analysis and Classification using Landmarks:Polygonal Wavelet Transform", 15th European Conference on Artificial Intelligence ECAI2002

[3] Luning. Li, Jaehyun So, Hyun-Chool Shin, and Youngjoon Han," An AAM-based Face Shape Classification Method Used for Facial Expression Recognition", International Journal of Research in Engineering and Technology (IJRET) Vol. 2, No. 4, 2013 ISSN 2277 – 4378

[4] Haibin Ling David W. Jacobs, "Shape Classification Using the InnerDistance", Pattern Analysis and Machine Intelligence, IEEE Transactions on Vol.:29 pp 286 – 299,2007

[5] Zhang Qian, Ding You-Dong, Lan Jian-Liang, Tu Yi, "Face Shape Classification Based on Active Shape Model and K-nearest Neighbour Algorithm", Computer Engineering, Vol.37 No.11, June 2011

[6] Milos Stojmenovie , Amiya Nayak " Shape based circularity measures of planar point sets", IEEE International Conference on Signal Processing and Communications, 2007. ICSPC 2007.

[7] Raul S. Montero, "State of the Art of Compactness and Circularity Measures", International Mathematical Forum, 4, 2009, no. 27, 1305 - 1335

[8] Tim cootes "Active Shape Model" ,Proceedings of European Conference on Computer Vision Vol.2 pp. 484-498 Springer,1998

[9] Jan Horejs "shape analysis using global shape measures"

[10] Milan Sonka, Vaclav Halvac, Roger Boyle, Image Processing, Analysis and Machine Vision

[11] Viola-John,"Real time face detection", International Journal of Computer Vision 57(2), 137–154, 2004

[12] Luning. Li , Jaehyun So, Hyun-Chool Shin, and Youngjoon Han," An AAM-based Face Shape Classification Method Used for Facial Expression Recognition", International Journal of Research in Engineering and Technology (IJRET) Vol. 2, No. 4, 2013 ISSN 2277 – 4378

[13] Kamal Nasreddine, Abdesslam Benzinou,"Vibrational Shape Matching For Shape Classification and Retrieval" Pattern Recognition Letters February 25, 2010

[14] D. Chaudhuri, N.K. Kushwaha, I. Sharif, and V. Gohri, "Unique Measure for Geometrical Shape Object Detection-based on Area Matching", Defense Science Journal, Vol. 62, No. 1, January 2012, pp. 58-66, DOI: 10.14429/dsj.62.942 , 2012,

[15] Refael C Gonzalez, Richard E Woods, Steven L Eddins, "Digital Image Processing", pp. 441-450

[16] Hybrid Feature Point Based Registration of 2D Abdominal CT Images, IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 4, No 4, July 2010

[17] http://theperfecthumanface.blogspot.in/2013_06_23_archive.html

[18] http://www.vision.caltech.edu/html-files/archive.html

[19] http://mmlab.ie.cuhk.edu.hk/archive/facesketch.html

[20] http://vis-www.cs.umass.edu/lfw/

N K Bansode, Completed his master degree in 2005 currently he is doing research computer science in the university of Pune. He has published a number of papers in the different international conferences and journals.

Dr P K Sinha, Senior Director (High Performance Computing) in Pune, India and Adjunct Professor at College of Engg. Pune, India. He is ACM Distinguished Engineer (2009) and IEEE Fellow(2013) with several research papers to his credit. He has contributed significant books including "Distributed Computing" and "Electronic Health Record: Standards, Coding Systems, Frameworks and Infrastructures". He is actively involved in academic excellence in the College of Engineering, University of Pune and mentoring several Research Projects at C-DAC, India.