



FINAL YEAR PROJECT REPORT

FACE CARTOONIZATION AND CARICATURE

GROUP MEMBERS

IRUM PERVAIZ 091420-196

DIMA NAEEM 091420-249

**UNIVERSITY OF MANAGEMENT AND
TECHNOLOGY**

FACE CARTOONIZATION and CARICATURE

Dima Naeem, Irum Pervaiz, Syed Farooq Ali, Hafsa Zafar
 School of Science and Technology,
 University of Management and Technology, Lahore
 {091420249, 091420196, farooq.ali, hafsa.zafar} @umt.edu.pk

Abstract -Human faces are attractive and effective in everyday communication. Interest in research activities in photo to cartoon conversion and face caricatures have gradually increased over the recent years. In this research, a cartoon system is presented which can generate a customized cartoon from an input picture. We work on frontal face images, extract features and create exaggerated cartoon-like effects by emphasizing on the unique features and characteristics of input images. By transforming and exaggerating the unique features including lips, eyes, eyebrows and the addition of accessories (hair, ear etc.), different cartoon expressions and facial effects including happiness, sadness, anger, excitement, surprise etc., are generated and caricature is formed

Keywords—Face Recognition; Caricature, Feature Extraction, Transformation

I. INTRODUCTION AND BACKGROUND

Human Face is enlisted in one of the finest sources of information. Facial characteristics are not always same for each human. Everyone loves cartoons. Cartoons are humorous, abusive, mocking and at times political. Sketching and drawing cartoons, is however, not easy. Well trained artists and professionals can do it well. Recently, many technologies including stroke rendering [7, 8] and tone control [7, 10] have been developed to make it possible for a skilled cartoonist to work entirely on the computer and by fusing these rendering technologies, various animation technology [9, 6] have been urbanized for interactive cartoon design application. Many common people love to personalize their identity in the digital world such as (online avatars). Recently, many websites [11, 12, 13] provide platforms to help users make a personalized cartoon by choosing different templates. These types of cartoon image can be used as personalized avatars, greeting cards, or special gifts (print on T-shirt).

The most recognizable personal feature is the face of the person. Thus inserting face in the cartoon picture is clearly the most effective and favorable way of cartoon personalization. This is a challenging task even for a professional artist. A suitable photo is first selected carefully from the various images in the album. Then, the face should be extracted of the photo carefully. Before effortlessly composing the target cartoon image, the size, rotation, and colors of the face should be adjusted. Every step of this process is time taking and its pre- required that the user should be familiar with image editing tools (e.g. Adobe Photoshop). These systems can be used in a variety of applications e.g., virtual chatting and personalized e-greeting cards. Computer-generated cartoon figure portraits are widely used in areas with a wide range of applications such as video conferencing, online games, e-cards, political and celebrity mocking and mobile digital entertainment. There have been efforts to produce caricatures automatically using computer graphics systems. For example, a system proposed by Akleman [4] et al. gives warping tools specifically designed for rapidly producing caricatures.

Caricature is a way of expressing more non-verbal information than pure face in people's communication. A caricature is a description of a person using exaggeration of some characteristics and oversimplification of others.

Computer graphic and Vision require different skills essential to design a caricature as compared to the caricatures created on paper. Due to the nature of the caricature work, the exaggerated results are stylized like a cartoon. Due to the development of computer graphics, in recent years, vigorous research is being done to create a caricature using computers. Research has been conducted on how to

produce caricatures automatically or semi-automatically using various computer graphics techniques. Most of these methods train their systems on how to generate and exaggerate stylized caricatures by using real artist prototype sketch drawings. The main drawback of these methods is they require a lot of manual work with many training prototypes drawn by artists. Additionally, the final appearance of the caricature is limited to the prototypes used in the training phase.

The common process of caricature is like this: First, the facial sketch is extracted in terms of the facial feature points, and then the feature points are exaggerated to new ones. According the new points, warping the face shape to the target position can produce the caricature.

Many cartoon creation systems [5, 6] focus on low-level editing and control tools for easy and flexible cartoon drawing and animation. Inkwell [4] developed some effective techniques on imposing layers, grouping/hierarchy of components and allowing the managing of motion functions. Similarly, the CharToon system [1] provided special skeleton-driven components an extensive set of building blocks to design faces and support to re-use components and pieces of animations. In [2], the system allows users to create a personalized cartoon and animation from an input face image. Inspired by artist books, in the recent work of [3], artistic drawings are distinguished by several key aspects, such as perspective, outlines and detailing by softer inks. In their work, the specification of strokes is decoupled from higher-level attributes.

Computer facial animation has been a successful research topic for more than 25 years, aiming at models which can be animated and used to produce facial expressions and reflecting the emotions and mouth movements for spoken text [10, 5]. Besides in film- and entertainment industry, there has been growing interest from the area of human-computer interaction technology. In spite of vast efforts, no easy-to-use technology has developed yet for producing faces with full realism and for faithfully animating them.

A. Applications

The caricature and cartoonization system have several applications worldwide and used in many online systems and entertainment purposes.

Table 1. A Table of possible applications of face caricature and cartoonization system.

AREAS	SPECIFIC APPLICATIONS
ENTERTAINMENT	VIDEO GAMES, ONLINE ENTERTAINMENT, MOBILE DIGITAL ENTERTAINMENT, INTERACTIVE GAMES, POLITICAL CARTOONS (HUMOROUS OR SATIRICAL)
COMICS	PORTRAIT OF CHARACTERS, COMIC BOOKS, OIL CARTOONS, COMIC STRIPS IN NEWSPAPERS
ANIMATIONS	TELEVISION AND FILMS, ANIMATED FACES ON WEB PAGES, REPRESENTING (DIFFERENT MOODS AND DIFFERENT EXPRESSIONS), SHORT ANIMATIONS
SPEECH SYNTHESIS	TALKING FACES WITH SPEECH SYNTHESIS
ONLINE GAMES	AVATARS IN COMPUTER GAMES, ONLINE CHATTING, VIRTUAL CONFERENCING
GRAPHICS APPLICATIONS	VIDEO ABSTRACTION,

PRINT MEDIA	EDITORIAL CARTOONS, NEWS PUBLICATIONS (HUMOR OR IRONY)
-------------	---

II. RELATED WORK

The artist can easily create any one caricature artificially exaggerating facial features. Can any computer do that from his/her real photograph automatically? Recently, there are increasing works on caricature generation [5]. Bruce Gooch et al [1] describe a method for creating two-tone illustrations and warping the face to a caricature by artificial grid regularity. Lin Liang et al [2] exaggerates the facial shape based on learnt prototype to reflect the personal features. Pei-Ying Chiang [5] use the average face and exaggerate the prominent features of the input face after comparison with the average face. Caricature generation from people's 2D real photograph involves shape exaggerating and texture rendering. The common process is: First, the facial sketch is extracted by facial feature points, and then the feature points are exaggerated to new ones. According the new points, warping the face shape to the target position can produce the caricature.

Most of Caricatures work can be roughly classified as manual exaggeration and automatic exaggeration. In the manual exaggeration technique, the caricatures are generated by selecting the portion of exaggeration or adjusting the degree of exaggeration by user directly. Brennan [16] proposed a caricature generator that the user can manually adjust the degree of exaggeration as much as the difference between the mean face and input face. Akleman [4] has technologically advanced a facial exaggeration interface that the user draw lines on components of input face, and move that lines.

Chiang [6] defined the features of the face according to the MPEG-4 standard, and the features of the input face were exaggerated as the father of artist drawn example by using warping. Lee [7] set the rules that create the caricature automatically without having to rely on an example of an artist. This has the advantage able to produce the varying results, but does not reflect the artist's style. In this work, the rules are set to create caricatures automatically and generate high quality results by defining the rules by using a particular artists' technique.

Studies on caricature have been widely used in the fields such as animation, film, media and face recognition. Suk [8] create the humanokid creature design using caricature in order to recognize person correctly. He also applied the concept of a caricature to create a cartoon character resemble the user's feature. However, these methods still lack of using high level (or semantic) understanding of images (e.g. Scene and object recognition), since automatically parsing a generic image is quite challenging and time consuming. Hence, some stylization systems allowed user interaction for extracting semantic content from images.

III. OUR METHODOLOGY

The system starts by inserting the frontal face image first followed by preprocessing on it. From preprocessing phase hair and ear are removed leaving only facial template. Next by applying facial feature detection algorithm [14] facial features including eyes, eyebrows, nose, lips are extracted. Cootes in [15] suggest an active shape algorithm suitable to detect objects like organs, bones and faces. The facial feature detection algorithm is a statistical shape model, learned from the shape vectors $s = (x_1, y_1, x_2, y_2, \dots, x_n, y_n)$ defining the x and y image coordinates of n landmarks. (Landmark represents a distinguishable point) and is characterized by its use of the Euclidean distance on one-dimensional profiles at each landmark. Its general idea is to try to locate each landmark

independently, correct the locations if necessary by looking at how the landmarks are located with respect to each other.

The feature detection model is an adaptive algorithm that iteratively improves its results. The main steps of this algorithm are as follows:

Input image of a face

1. Generate the start shape by locating the overall position of the face
2. Repeat
 - 2a. for each shape point
 - 2b. for each offset (i.e. Look at the area around the point)
 - 2c. build a profile by sampling the area around the offset
 - 2d. Measure the fit of the profile against the Profile Model
 - 2e. Move the point to the offset of the best profile match
3. Adjust the suggested shape to conform to the Shape Model
4. Until convergence (i.e. By no further improvements in it are possible)

Output shape giving the (x, y) coordinates of the face landmarks.

The results of facial feature detection are shown below in fig. 2. Extracted Features are represented by landmarks fig 2 (a) Bboxfig 2 (b). Bounding Box crops the extracted feature and form a box around it.

The input image dimensions should be 1024*768. After extracting features, using Cartoon template applies cartoon texture mapping (done using Delaunay triangulation) [14]. With the help of Delaunay, the facial features of the input image are warped on the cartoon template. The results are shown in fig. 3 for cartoon template and fig. 4 shows triangular meshes on the images. After Cartoon Texture Mapping, transformation including scaling, shearing is applied to the extracted features and the results are shown in the next section. Shearing factor of +1 and -1 was applied for right and left shearing of lips respectively. Scaling factor of 0.5 and 1.5 are used in the horizontal direction for scaling down and scaling up lips. Scale Factor of 0.75 is used to scale down and up eyes. For the Eyebrows part, a combination of scaled eyebrows and eyes is implemented. Moreover to give cartoonish effect, facial expression including smile, sad, anger, confused, blank, serious and eye wink is implemented by changing the scale factors.

To give smiling and sad effect, smile lips and sad lips template are warped on the input image. Similarly, angry eyes templates are warped to create an angry expression. For serious look, scale factor 2 is applied in the horizontal direction in eyes and scale factor 1.75 in the vertical direction in eyebrows. To create, blank and serious lips scale factor 2 is applied in the x and y direction respectively. For Eye wink, scale factor 0.5 in y direction is applied on left eye. After applying a transformation on the extracted features separately, transformed features are warped to the original image. The Delaunay triangulation is used for faces and template (dividing the face in different triangles), then the correspondence between triangles of the face and template is found, then template image and input image are warped to generate cartoon template effect

Fig 1 shows the flowchart of our system

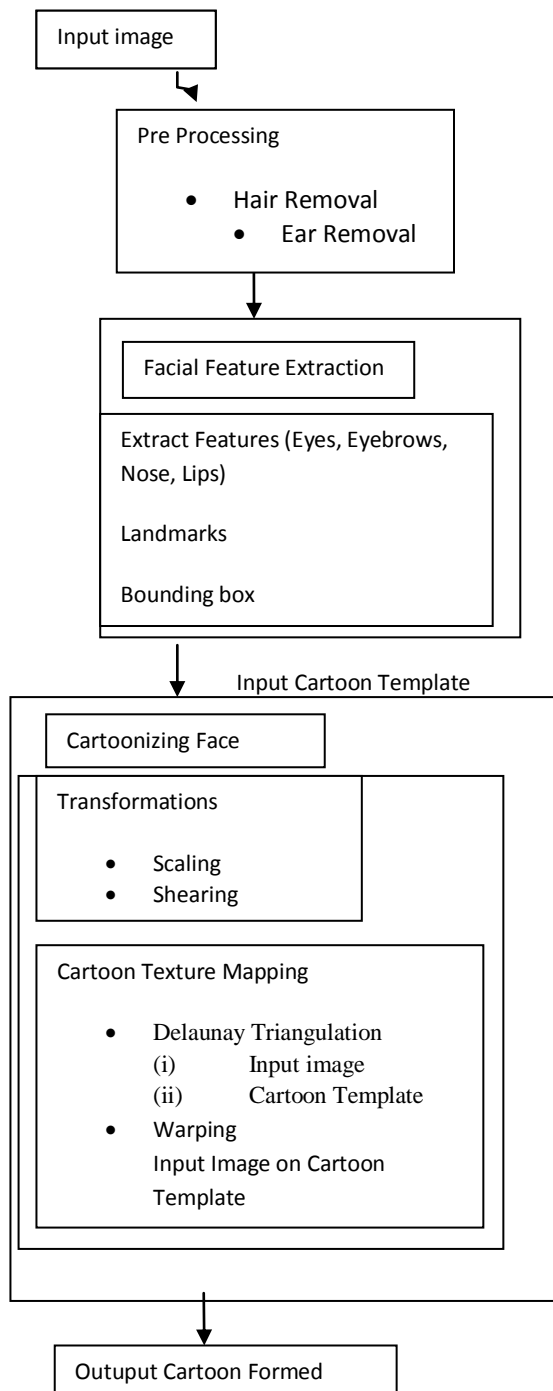


Fig. 1 Implementation Flowchart

IV. RESULTS AND DISCUSSION

Facial Feature Detection

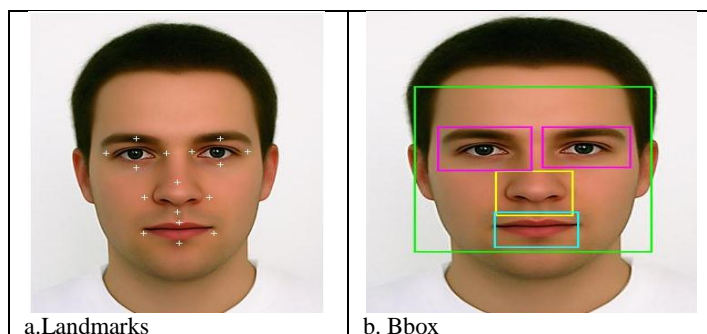


Fig.2 Results

Cartoon Texture Mapping/ Delaunay Triangulation

After extracting features, the results are expressed in the bounding box and landmarks. Cartoon texture mapping makes use of triangle mesh to do the cartoon texture mapping. The main aim is to map the obtained features from facial feature detection algorithm to cartoon template. Using Delaunay Triangulation [14] technique, the real facial feature points are triangulated. The results are shown in fig 3 and fig 4.

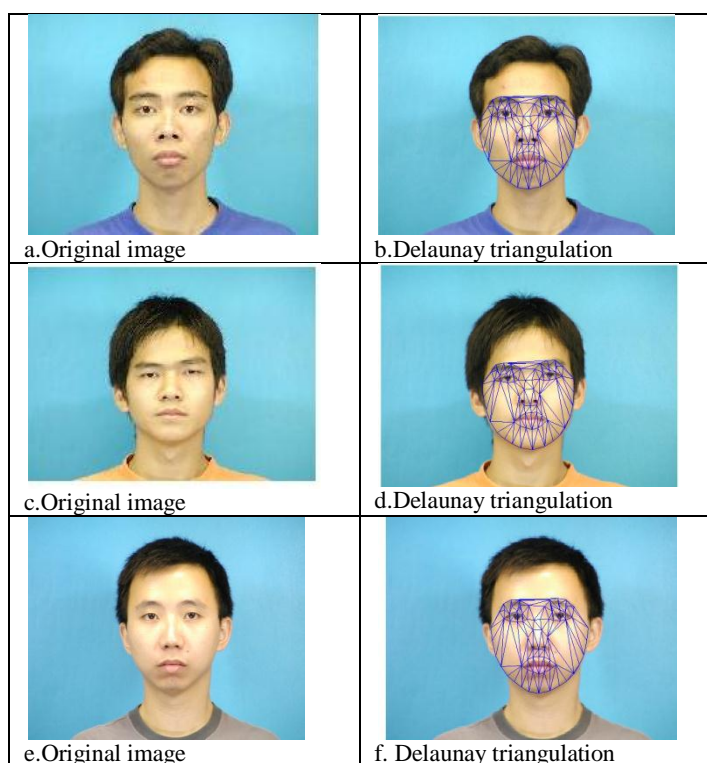


Fig 3 Delaunay Triangulation results [17]

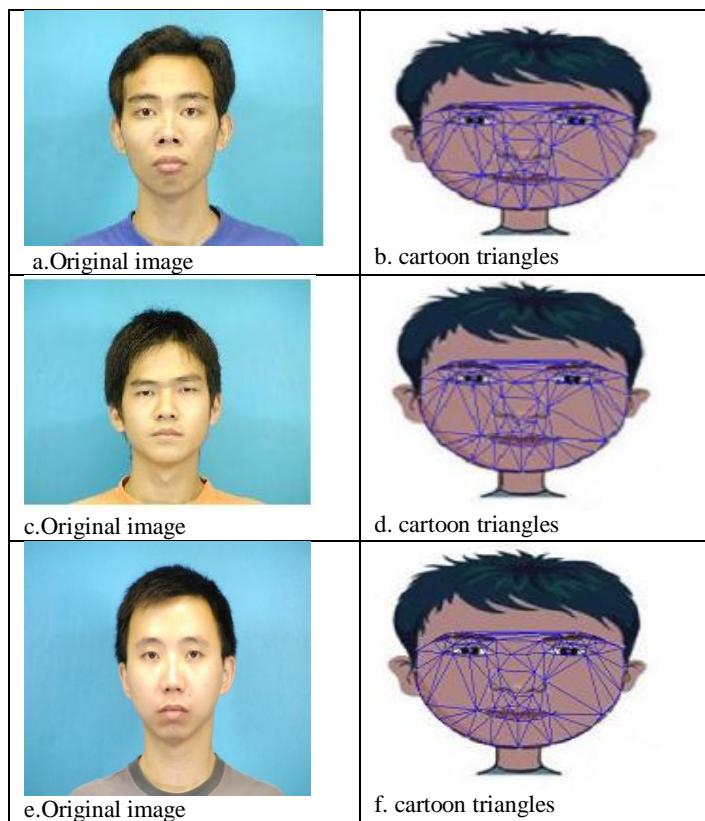


Fig. 4 Delaunay Triangulation on Cartoon Template[17]

Transformation on Lips

Using feature detection algorithm, lips feature points are detected,

Lips extracted and transformed.

Transformed lips are warped in the original image

Different transformations including Scaling, Shear has been applied to the lips. Scaling factor of 0.5 and 1.5 are used in the horizontal direction for scaling down and scaling up as shown below.

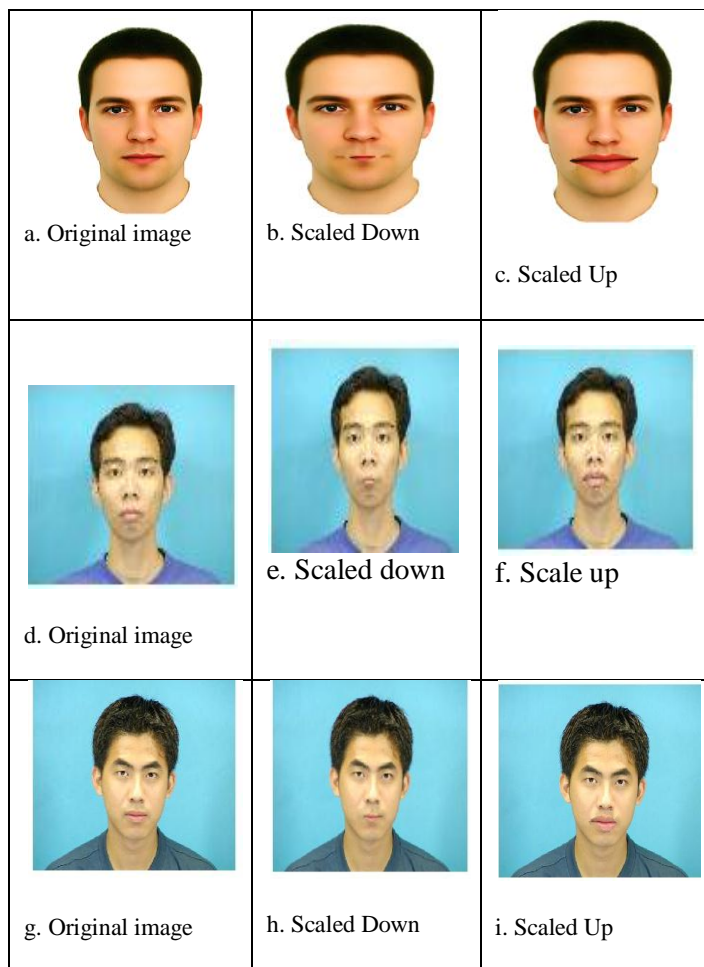


Fig 5. Transformations on Lips [17]

For Sheared Lips, results are shown in Fig. 2; For Shearing Lips to right and left side a scale factor 1 is applied i.e. +1 to the right side and -1 for left.

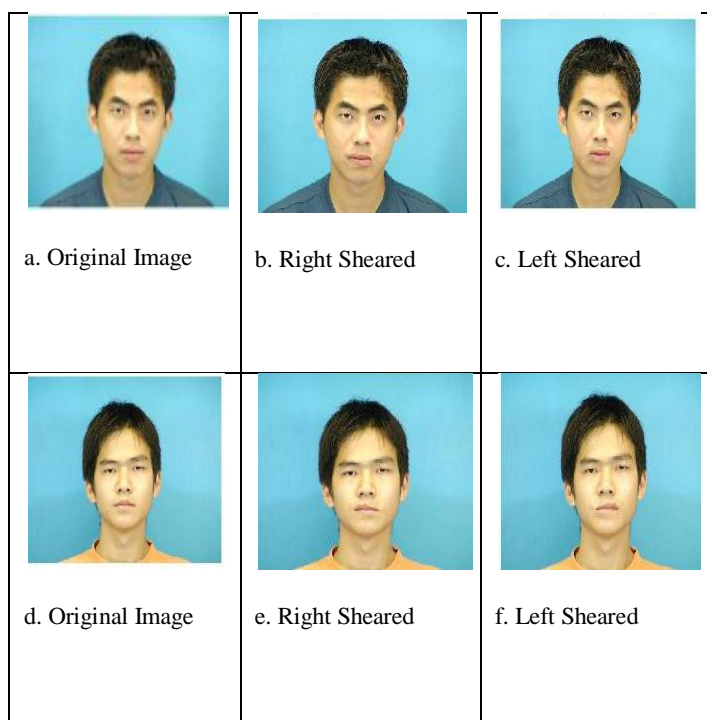




Fig. 6 Sheared Lips [17]

Transformation on Eyes and Eye Brows

Scale Factor of 0.75 is used to scale down and up eyes and the results are shown below.

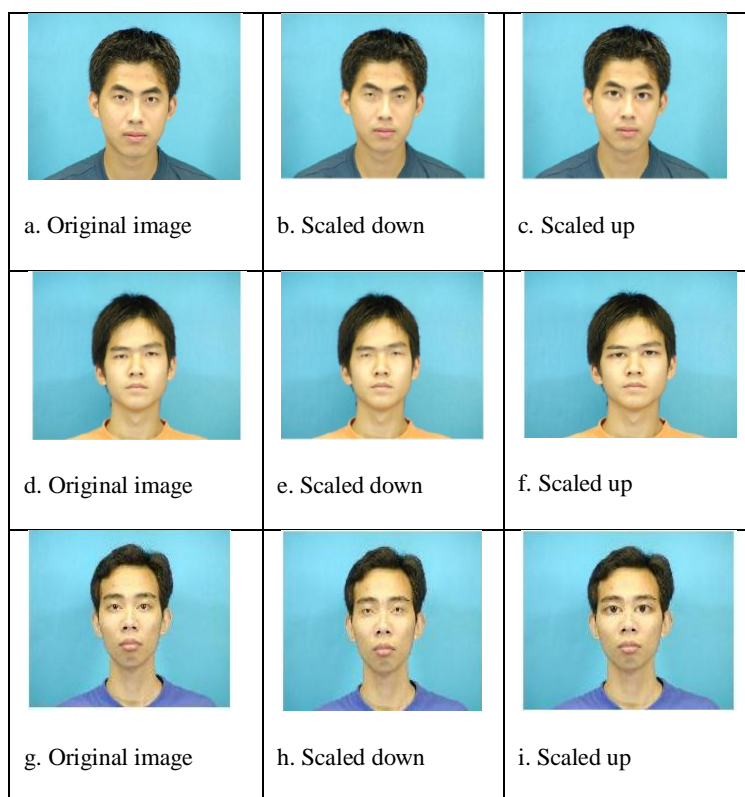


Fig.7 Eye Transformation [17]

For the Eyebrows part, a combination of scaled eyebrows and eyes was implemented.

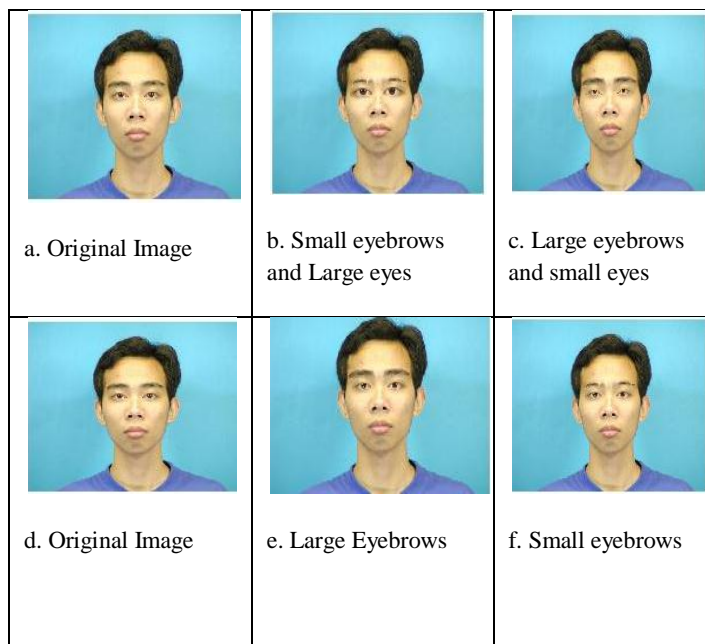


Fig. 8 Eye and Eyebrows transformation [17]

Colored Features

By changing the Pixel value, colored features (eyes, lips) are obtained and the results are shown in Fig 9 (Colored Lips) and Fig 10 (Colored Eyes).

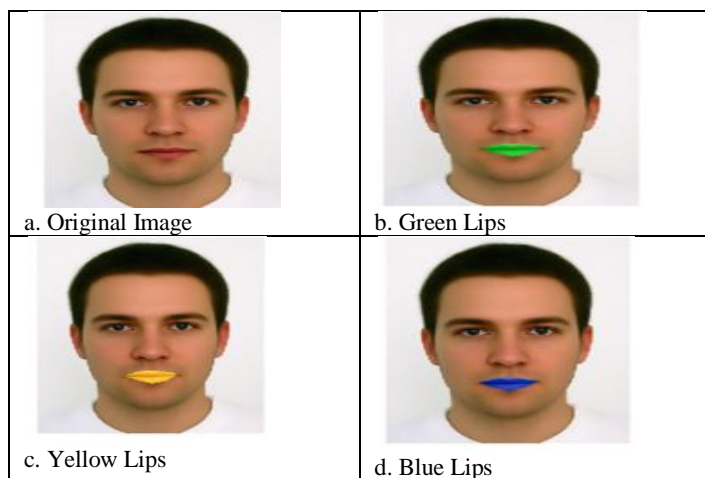
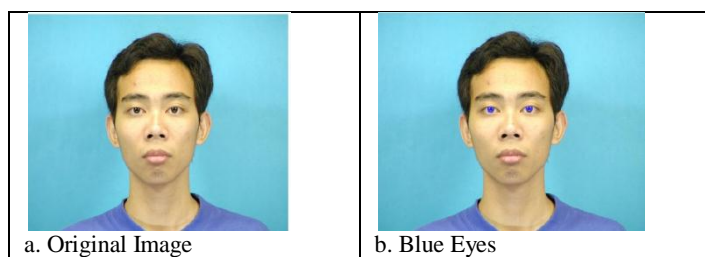


Fig. 9 Colored Lips [17]



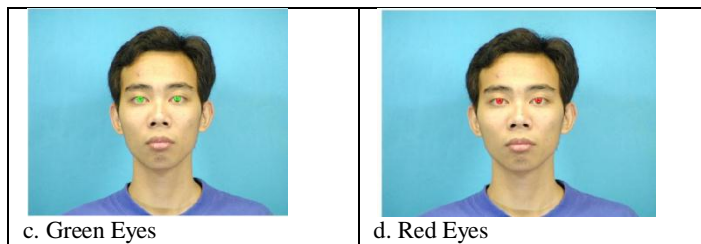


Fig. 10 Colored Eyes [17]

Combination of Transformation on Lips, Eyes, Eye Brows.

Different face expressions Smile, Sad and Confused are obtained by using the following approach

- dividing bbox for lips into 6 equal parts and each chunk the value of γ is scaled.
- For each column, scaling γ using updating the scale factor δ with θ .

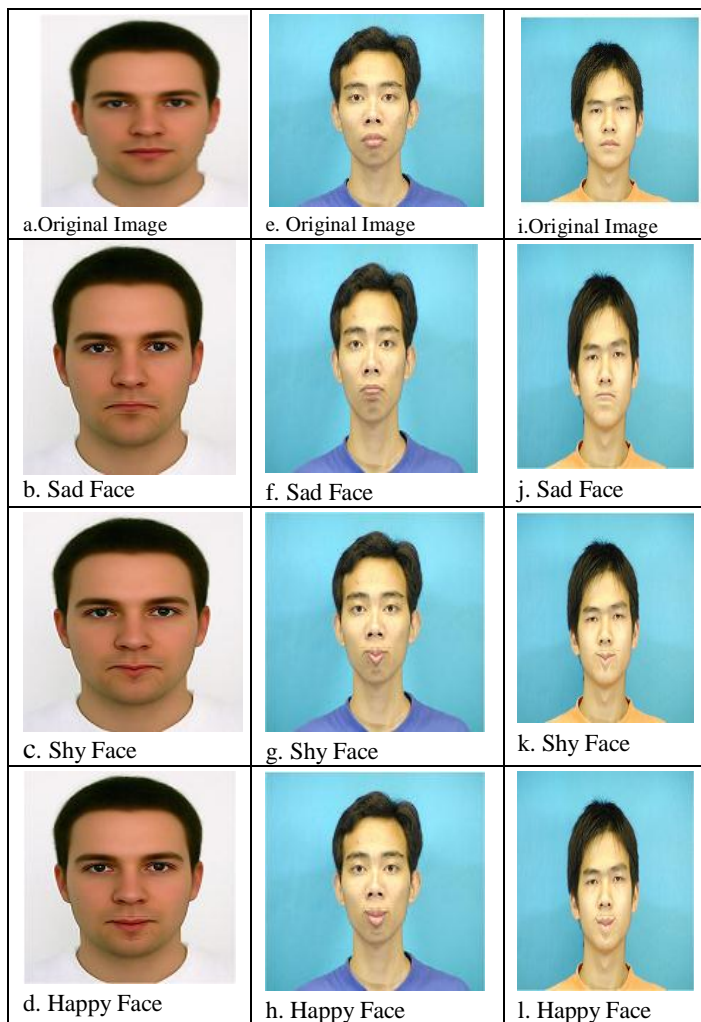


Fig 11. Expressions

To create blank and confused expression, lips are scaled in x direction with scale factor 2 and lips are scaled in y direction with scale factor 2 to create serious expression.

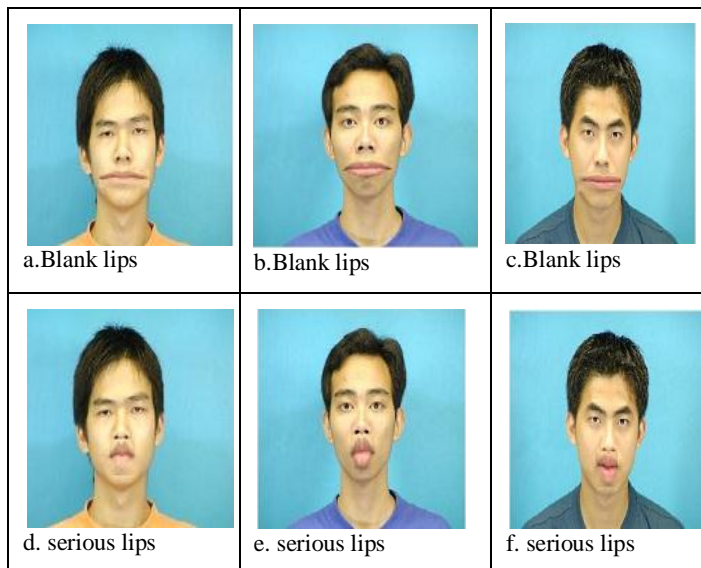


Fig. 12 Lips with Different Expressions[17]

Different expressions are obtained by applying various transformations on the eyes and eyebrows. Surprised Eye is obtained by scaling the eyes in y direction with scale factor 2 and scaling eyebrows in y direction with scale factor 1.75 and the result is displayed in fig 15 (a). Scaling eyes in y direction with scale factor 1.75 and result is shown in fig 15 (b). For eyes wink left eye is scaled down by factor 0.5 and eyebrows scaled up with scale factor 2 and result shown in fig 15 (c).



Fig 13 Eyes with Different Expressions [17]

Caricature Formed

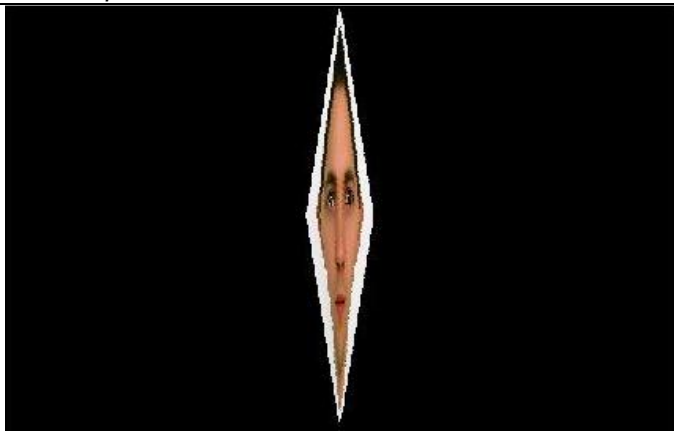
The whole image is transformed using the following approach.

For each row:

- Scaling in horizontal direction is applied by updating the value of α in every iteration.
- $\alpha = \alpha + \beta$



a. Original Image

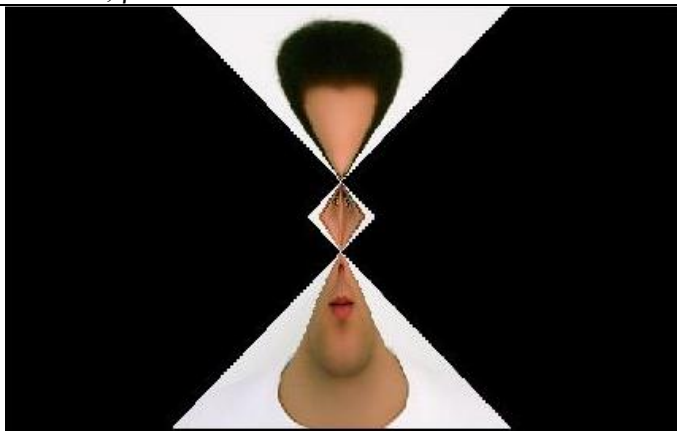
b. $\alpha = 0; \beta = 0.003$ c. $\alpha = 0; \beta = 0.001$ d. $\alpha = 0.25; \beta = 0.006$



e. $\alpha = 0.25; \beta = 0.003$



f. $\alpha = 0.1; \beta = 0.001$



g. $\alpha = 0.25; \beta = 0.003$



h. $\alpha = 0.5; \beta = 0.001$



i. $\alpha = 0.75; \beta = 0.002$



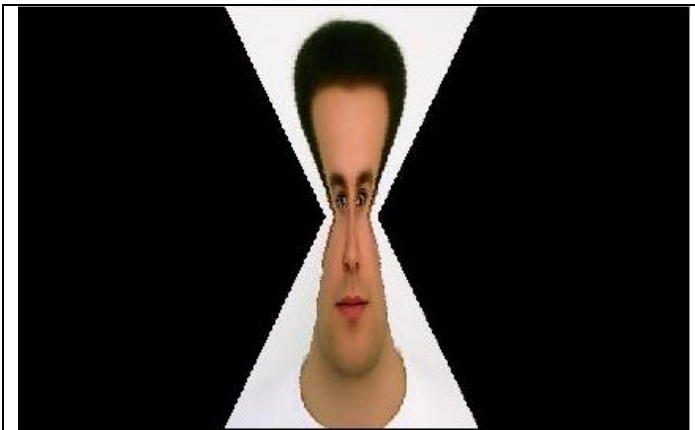
j. $\alpha = 0.75; \beta = 0.006$



k. $\alpha = 0.75; \beta = 0.006$



l. $\alpha = 0.75; \beta = 0.003$



m. $\alpha = 1$; $\beta = 0.003$



n. $\alpha = 1$; $\beta = 0.006$



o. $\alpha = 1$; $\beta = 0.005$



p. $\alpha = 1$; $\beta = 0.004$

Fig 14. Caricature formed changing the scale factors.

Cartoon Formed

The Delaunay triangulation is used for faces and template (dividing the face in different triangles), then the correspondence between triangles of the face and template is found, then features extracted are warped on to the cartoon template and the final cartoon formed applying transformations are obtained.

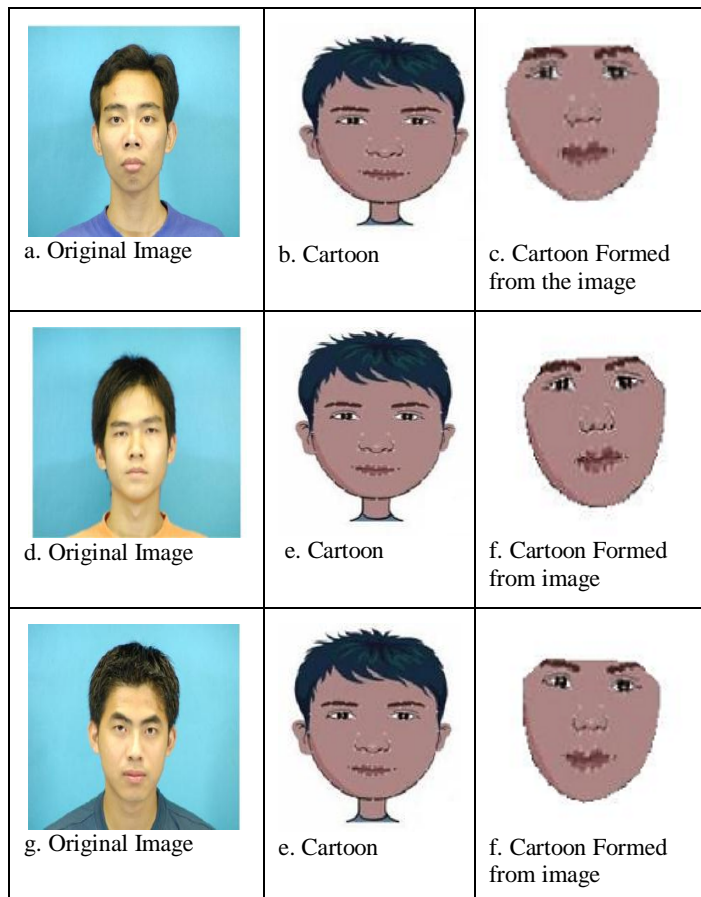


Fig. 15 cartoon formed from image [17]

V. CONCLUSION AND FUTURE WORK

In this work we present and explain our approach to form a caricature. Our system transforms different facial features and exaggerates them to form a cartoonized shape. The cartoon generated by using our system looks funny, lively and somewhat resembling the original person. The approach can be extended to side views. We also plan to introduce desktop and mobile applications that will be able to generate these effects on the given input image.