An Enhanced Image Warping Technique

Shakeel Doushant Imrith *shakeel.imrith@umail.uom.ac.mu*
Department of Computer Science and Engineering,
University of Mauritius,
Reduit, Mauritius

Maleika Heenaye- Mamode Khan *m.mamodekhan@uom.ac.mu*
Department of Computer Science and Engineering,
University of Mauritius,
Reduit, Mauritius

Abstract

Recently image warping is becoming a forefront subject and is attracting the attention of researchers. The motivation underpinning in exploring image warping is that it is producing wonderful effects on photographs and in film industries. Various warping algorithms are been devised to cater for the challenges posed by new image requirements. So far in literature, warping algorithms have been applied individually to produce pleasing effects. However, the amalgamation of several algorithms using appropriate proportions has been put aside. Furthermore, some existing warping algorithms lose some important features like contours in an image. In this paper, analysis of the mixture of morphing techniques has been applied on images to produce caricatures where the contours are cautiously preserved. The aesthetic effects of this newly devised amalgam algorithm is desirable to produce outstanding effects on face images.

Keywords: Image Morphing, Caricature, Blending.

1. INTRODUCTION

Nowadays, pictures are used everywhere, from the simple family picture from a digital camera to the 2 dimensional animations in the film industry. The pictures taken can experience optical distortions introduced by a camera or viewing perspective. There is an explosive need in correcting and manipulation these images to have a compelling and aesthetically pleasing effect on these pictures. Thus, image warping is a forefront subject which is gaining momentum [1, 2] . In fact, image warping is a process of geometrically transforming an image, based on pixel manipulation and color blending. It is in essence a transformation that changes the spatial configuration of an image [3, 4]. In the last decade, several warping techniques are being devised to quench the demand of film industries.

Many techniques have been devised in this field. Gooch et al. [5] used a 3 by 3 free form deformation in order to overstress the face image. Liang et al. [6] used the Partial Least Squares learning in order to predict the best pair if an image face was given. Last but not the least, there are several basic techniques like brightness, contrast, RGB (Red, Green, Blue), CMYK (Cyan, Magenta, Yellow, Black) and Hue, Saturation and Lightning which have been devised. These techniques have been amalgamated in order to form the new warping techniques which exist nowadays. For instance, contrast and brightness have been used in order to create techniques like noise or dithering [7]. Individually, these techniques hold little value but if they are combined in the right proportion, they may yield fantastic results. Xiong Bing el al. [8] demonstrated that orientation information, also termed as intensity level in the pixels can be used to map snakes effectively in a continuous way. Based on the same logic, if snakes can be continuous, it means that the contrast found on the contours forms a repeating pattern which draws the shapes of a face image. Moreover, as specified earlier, Gooch et al. have claimed that we recognize faces based on the difference in features present on them. Thus, they presented a caricature generator,

using a 3 by 3 deformation grid. Chiang et al. [9] exaggerated the most common features of a face, comparing it with the features of an average face. Chen et al. [10], on the other hand, did not overstressed upon the deformation of a face image in order to create a caricature. Instead, they learned art style from pairs of images and associated sketches drawn in a particular style. Their approach takes as input a face image and generates a well shaped version of the image; that is, an elegant caricature. Freeman et al. [11] translated a sketch into different styles by translating the sketch through an example-based system. However, they focused on style transfer rather than generating a stylistic sketch from an image. Nguyen et al. [12] proposed the use of primitives in order to stylize the personality and structure of the portrait. They used the Golden Ratio, specified by Gooch et al. and further build on this to propose a novel decomposition of key exaggeration and suppression features, for constrained adaptation to cartoon templates. Wen et al. [13] have developed an image warping method based on level set. In this work, the image was warped locally and globally through level set dynamic evolution with a certain velocity field which controls the deformation.

Several warping techniques exist. So far, these traditional methods have been applied individually to generate effects on images. There are also many challenges like the disparity of contours in warped images that have not been attended to. Based on these facts, a new warping technique has been devised to produce enhanced caricature without fading the contour lines of the images. This new algorithm creates a black and white copy of a face image, based on the difference in contrast found in the contours of face images. The colors found on the face have different textures and hence different levels or degree of the same color; hence different contrast on different regions of the face. This new algorithm uses 5 of the basic warping techniques in order to deploy its effect on a face image. The results obtained after applying the fused devised algorithm provides more appealing results compared to individual algorithm. The rest of the paper is presented as follows. Section 2 gives an explanation on the basic warping techniques used. Section 3 gives the design of the new technique; that is, the proposed model. Section 4 gives the experimental results for this paper and lastly, section 5 gives the conclusion and the future works with respect to this paper.

2. WARPING TECHNIQUES

The warping techniques used to create the new technique are simple warping techniques, that is, modify the intensity and color space of an image. These techniques are based on the everyday life colors as well as the color models used in various part of our life, that is, in monitors, printers, for the human eye and for compression standards. To summarize, these techniques form part directly or indirectly of human psycho-visual aspect. As we know, human beings are more able to perceive colors in the form of Hue, Saturation and Brightness. However, other color models, such as RGB, CMYK, grayscale and contrast, have their importance. For instance, if contrast and CMYK are used in relevant proportions, it gives much weight to contrasted edges in any face image. In this section, the warping techniques applied on face images for the caricatures are explicitly explained.

2.1 RGB Preliminaries

The RGB color, used mostly in monitors, and human beings, being less prone to chrominance than luminance, are less able to recognize small changes in RGB color model. However, if this change reflects an impact on the intensity as well, the change, based on the psycho-visual ability of human, will be easily perceived. In this paper, we will use this technique in a proportion that it will yield a change in the contrast of the face image. In other words, it will help us to remove brighter colors and keep colors with more depth, so as to capture the edges of the face image. The main advantage in this is that it will enable us to modify the image without changing the aspect and features found in the image. Its disadvantage is that in small proportions, practically no changes are seen. The following figure shows the effects of RGB on images.

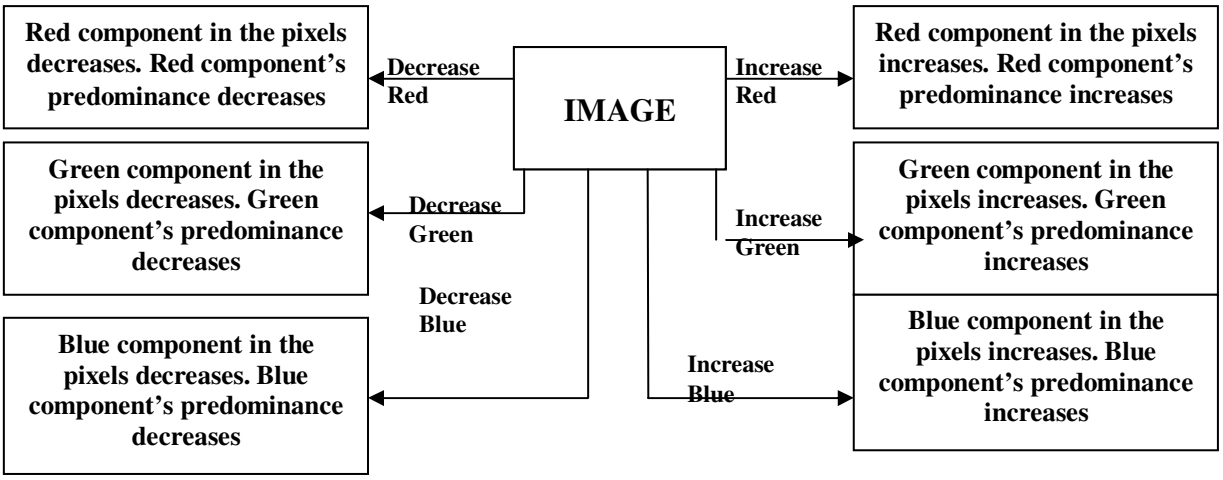


FIGURE 1: Effects of RGB on images

FIGURE 2: Example of Effects of RGB on images

2.2 CMYK Preliminaries

The CMYK color model is another technique used mainly for printing purposes where the black color needs to be dominant. This color model is of great help as it is a subtractive color model, as opposed to RGB. The black generated by this model will be used to generate the contours and edges of facial features, which are much contrasted in black color. This CMYK model will allow us to produce our final version of caricature by removing all the other colors and leaving the black color as the dominant color. In this way, the lighter parts of the face image will be removed. Thus, the main advantage of the CMYK model is its subtractive nature and its ability to make the contours of face images predominant. The results for the CMYK model are shown below.

Original Image Cyan Enhanced Magenta Enhanced

Yellow Enhanced

All 4 components enhanced

FIGURE 3: Example of Effects of CMYK on images

2.3 Grayscale Preliminaries

Another color model that is to be used is the grayscale color model. This technique helps in achieving uniformity of color in the pixels as well as allowing lighter pixels to be represented in light grey and contours to be represented in darker grey colors. The grayscale model allows us to remove different levels of colors pertaining to the same color so as to achieve regularity in terms of pixel intensity. The following figure shows the effect of grayscale on images.

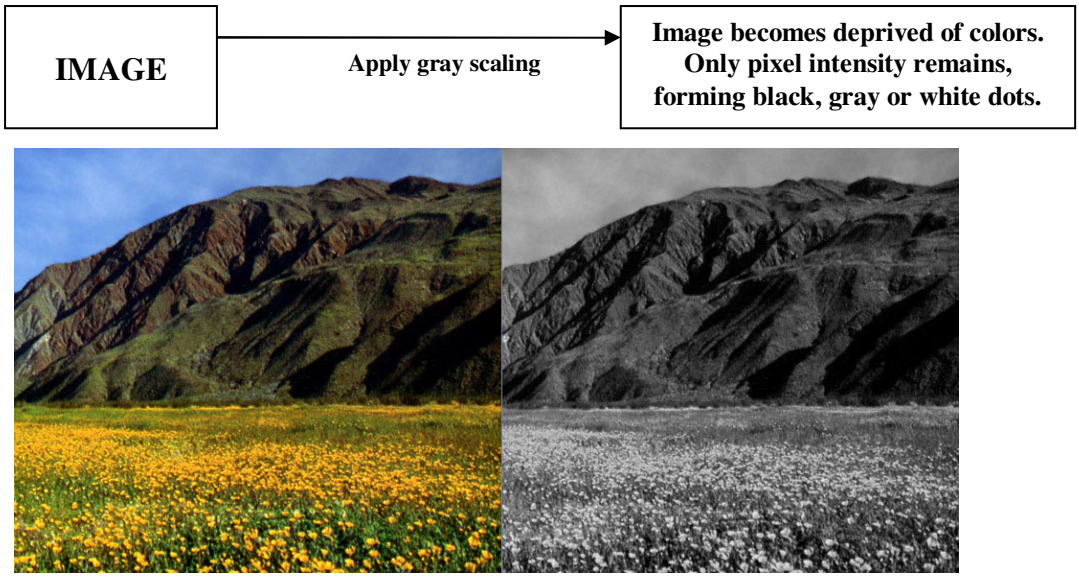


FIGURE 4: Example of Effects of grayscale preliminary on images

2.4 HSB Preliminaries

Human beings are more used to the hue, saturation and brightness color model. Hue is the attribute of a visual sensation according to which an area appears to be similar to one of the perceived colors such as red, green and blue. Saturation is the colorfulness of an area judged in proportion to its brightness. Brightness is the attribute of a visual sensation to which an area appears to emit more or less light. It is a fact that they have very little importance when used separately. However, when they are used together as a color model, they produce enhancing results. For instance, the hue will allow us to view the face image in different values of the RGB model. Saturation will help us to attenuate the colorfulness of the image, while the brightness will enable us to increase the pixel intensity of the pixels. The following figure shows the effect of applying HSB technique on images.

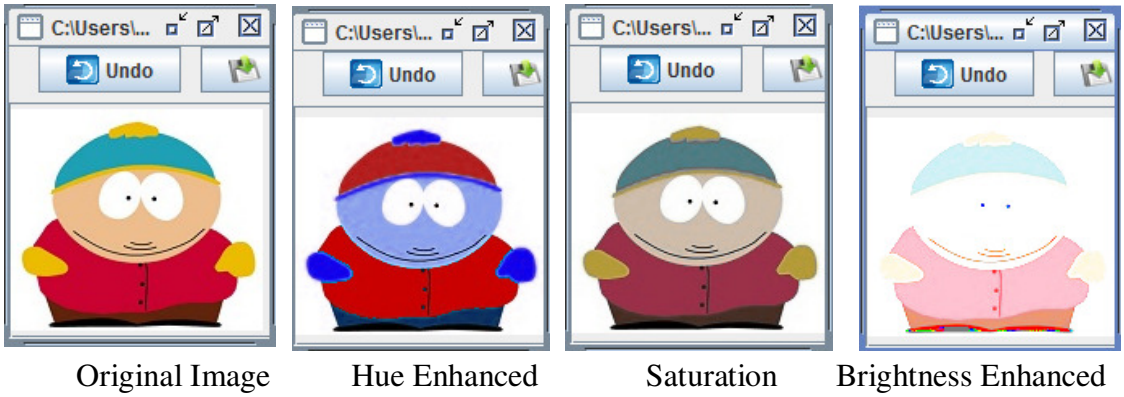


FIGURE 5: Example of Effects of HSB on images

2.5 Contrast Preliminaries

Another basic warping technique is the contrast model which allows us to inject some color disparity in contours or edges which are less defined due to photography errors. It enables features to be well shaped before the final touch of black and white drawing is applied to the face image.

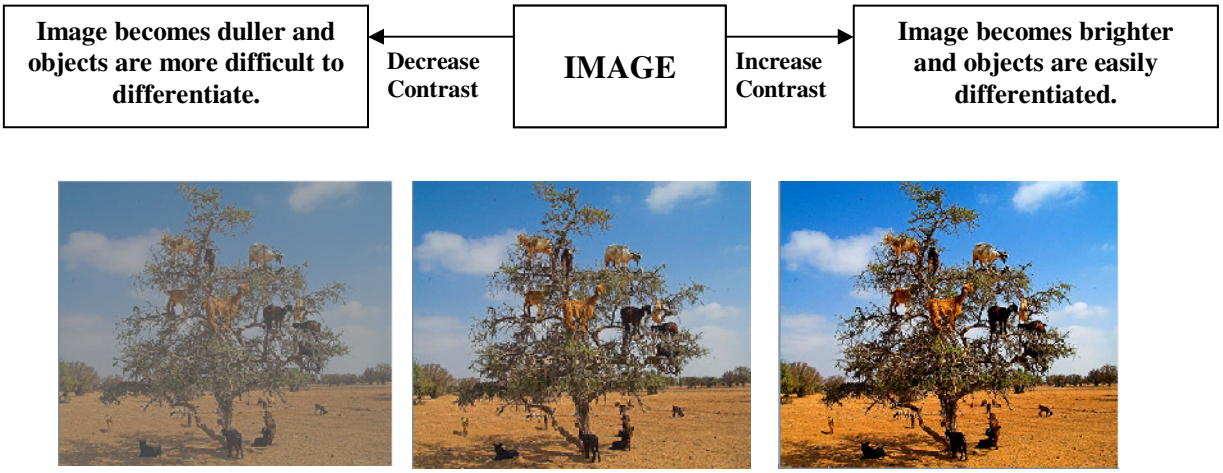


FIGURE 6: Example of Effects of contrast preliminaries on images

2.6 Gamma Preliminaries

The gamma model is one which allows the uniform darkening of the pixels in an image. It helps in correcting a picture taken in very bright sunlight, by uniformly darkening pixels, irrespective of their respective intensities or the intensities of the surrounding pixels. On the other hand, if we decrease the gamma, it helps in making the image brighter, as shown below.

FIGURE 7: Example of Effects of Gamma preliminaries on images

These techniques discussed in this section are very basic and quite simple to implement. As illustrated in the above figures, they enhance contrast to some extent if they are used in the correct proportions. However, when they are applied individually, they give negligible enhancement to the face image like increasing the luminosity to some extent. Another issue is that the effect of warping techniques on images to produce caricatures is different. The following section gives an overview of different caricatures when applying warping techniques.

3. WARPING TECHNIQUES TO PRODUCE CARICATURES

As discussed in section 2.0, the effect of the basic warping techniques varies from one algorithm to the other. Special attention should be given to these techniques when building caricatures. In many cases, when caricatures are built, contours and edges are lost thus losing the appropriate presentation of the image. Caricature was used earlier to warp image and they were presented in the form of primitives, which are used to match features of any face image. The end result is just like applying the cartooning effect as shown in the figure below.

FIGURE 8: Image Caricature

Caricature can also be presented as the total deformation of face images. This was made possible by using the golden ratio and features and shapes were exaggerated. The end result was in the form of a puppet as shown in Figure 9.

FIGURE 9: Image Deformation

Last but not the least, caricature was termed in the form of polymorphing, that is, the use of different morphing algorithms on different face image in order to obtain the caricature as shown in figure 10.

FIGURE 10: Image Polymorphing

It is challenging to produce the caricatures as shown in figure 8, 9 and 10. The basic warping techniques that have been discussed in section 2 cannot produce such effect when applied individually. In fact, the essential use of the black color and ways of enhancing contrast was disregarded. While manipulating simple and basic pixel color and intensity manipulating

algorithm, enhancement in contrast can be made possible. Based on this enhancement, a black and white caricature can be obtained by removing all colors from any color space while keeping the black color in order to make the edges dominant. As mentioned earlier, there are scopes in developing more enhanced warping techniques to produce appealing effects on images. When the different techniques are used as an amalgam in different proportions, they yield about exquisite characteristics to face images. On this basis, a design is proposed and discussed in the next section.

4. IMPLEMENTATION OF PROPOSED WARPING TECHNIQUE

The enhanced algorithm devised consists of an amalgamation of 5 basic techniques namely: RGB, CMYK, grayscale, HSB and contrast preliminaries. However, the orders and proportion in which they are applied should be chosen cautiously. The following is the algorithm of the proposed warping technique:

On preloaded image, do the following:

- Check if pixels are uniform
  - If not uniform, apply grayscale
- Adjust RGB
  - Adjust: R = -255, G = -127, B = -84
- Make uniform again
  - Apply grayscale
- Are some edges missing?
  - If yes, apply contrast by 57.
- Make uniform again
  - Apply grayscale
- Adjust RGB
  - Adjust: R = -186, G = -56, B = -255
- Is brightness little?
  - If yes, increase HSB.
    - Adjust H = 41, S = 0.1, B = 0.4
- Make uniform again
  - Apply grayscale
- Remove all colors
  - Adjust CMYK to remove all Cyan, Magenta and Yellow.
- Are edges defined?
  - If yes, stop.
  - If no, increase black until edges are drawn.

FIGURE 11: Newly devised algorithm

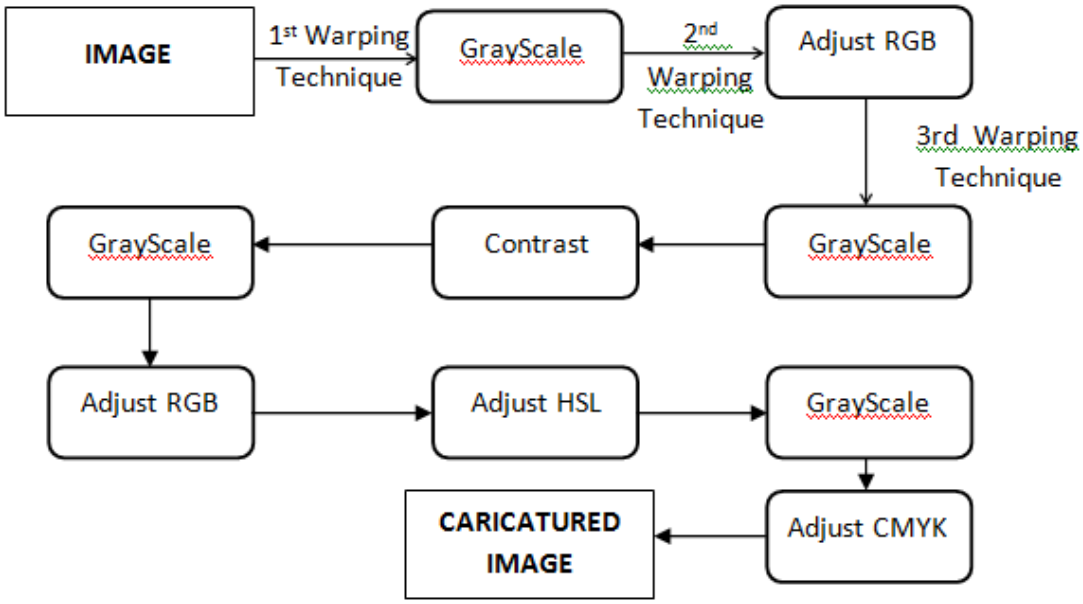


FIGURE 12: Newly devised design

First of all, there is a need to bring about uniformity in pixel levels and remove colors. The second step is used to darken the image so that lighter intensity pixels are removed in subsequent steps. The third step helps to bring about some uniformity again to the face image. The forth step will clarify the image a bit and help in defining the contours well. Contours which were already well defined are amplified, while contours, which lack contrast, are given a boost. The fifth step may not yield any change to the current image but its aftermath cannot be disregarded. The sixth step will darken the image beyond recognition but the features are well distinct from the rest of the image. The seventh step deals with the human psycho-visual ability and will help in modifying the RGB space, decrease colorfulness of the image and brighten it so as to see the contours well defined. Uniformity is applied again in the eighth step to unify the colors brought about by the seventh step. Finally the last step will remove all colors from the pixels and inject some black color only to the image. This will make pixels of light intensity to disappear, which results in sharper and nicer contours of the face image.

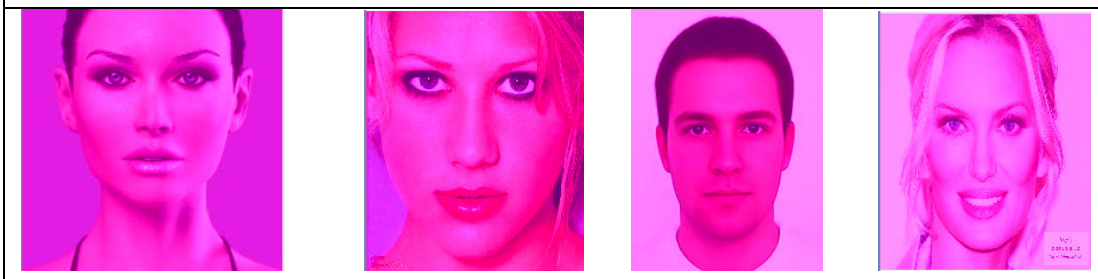
A database of different face images were used to experiment with the newly devised algorithm and some of the results are shown in the following section.

5. EXPERIMENTAL RESULTS

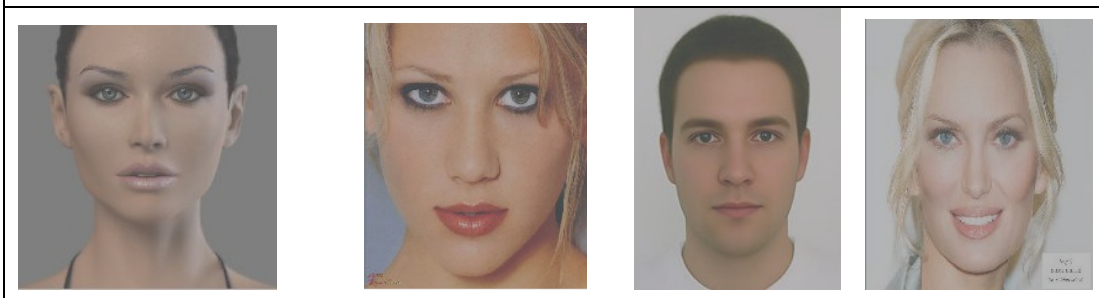
The first table shows the result of the individual warping algorithms, that is, Grayscale, RGB, Contrast, HSB and CMYK applied on 4 different face images taken from the face databases.

Original images taken from the database

Application of GrayScale

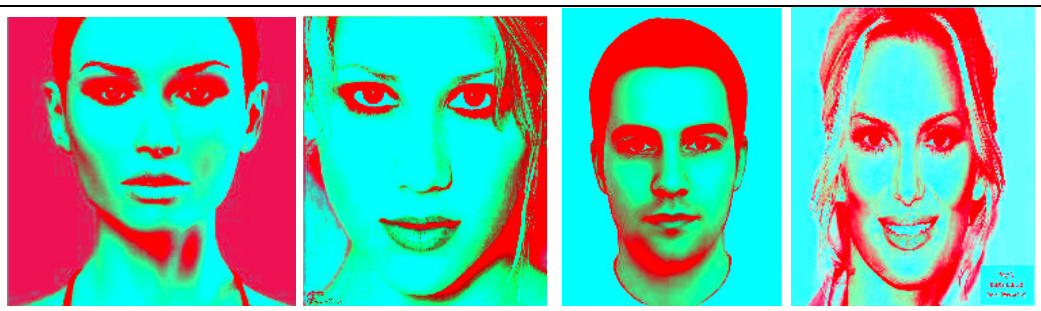


Application of RGB (R = 100, G = -100, B = 100)



Application of Contrast (C = 70)

Application of HSB (H = 150, S = 0.3, B = 0.1)



Application of CMYK (C = 5, M = -5, Y = -2, K = 150)

FIGURE 13: Application of gray scale, RGB, Contrast, HSB and CMYK individually

Figure 12 shows the effect of warping algorithms applied individually on face images. The effects are different when applying the newly devised algorithms presented in this paper. All the edges and the contours are preserved making the algorithm an ideal for caricatures. Figure 13 shows the face images after applying the algorithm presented in this paper.

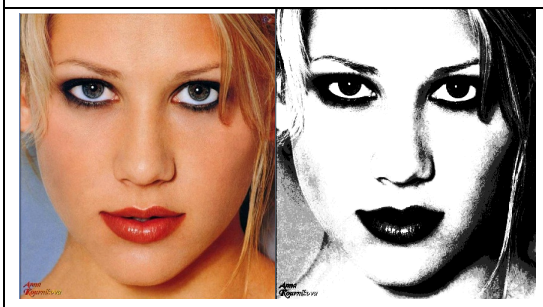
Techniques applied: Grayscale + RGB + Contrast + HSB + CMYK	
  	These results show how the contours and edges have been defined in each of the images. The left most image shows the original image and the right most one shows the caricatured image. Even computer generated images (like the third image) can be well caricatured.

FIGURE 14: Application of newly devised algorithm

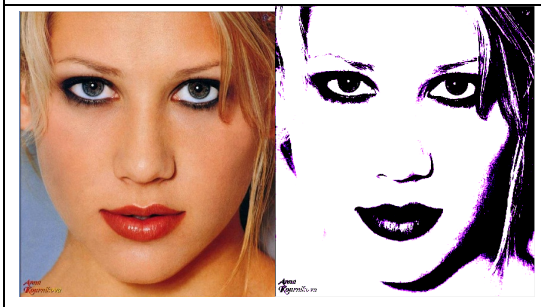
In the above example, the caricature technique in section 4 was applied in the following proportions:

- Grayscale
- RGB applied: R = -255, G = -127, B = -84
- Grayscale
- Contrast applied: Contrast = 57
- Grayscale
- RGB applied: R = -186, G = -56, B = -255
- HSL applied: H = 41, S = 0.1, L = 0.4
- Grayscale
- CMYK applied: C = -25, M = -25, Y = -25, K = Adjust at will until nice effect is observed.

The devised application was also tested with some missing warping algorithms among the five algorithms to analyze the effect that they have on the face images. It can be noticed that contours are not well defined leading to the loss of some features representing the images or the colors are not properly defined.

The first and last step of the design only will be used. (Greyscale + CMYK)	
	The contours are not well defined, especially in the second image. If we compare it with the above results, the difference can be easily noticed.

The first, second and last step of the design only will be used. (Greyscale + RGB + CMYK)	
	Contours appear but there seems to be some amalgamation of colors. Moreover, a portion of blue color appears.
	
The first, second, seventh and last step of the design only will be used. (Greyscale + RGB + HSB + CMYK)	
	Contours appear but there seems to be some amalgamation of colors. Moreover, a portion of blue color appears.

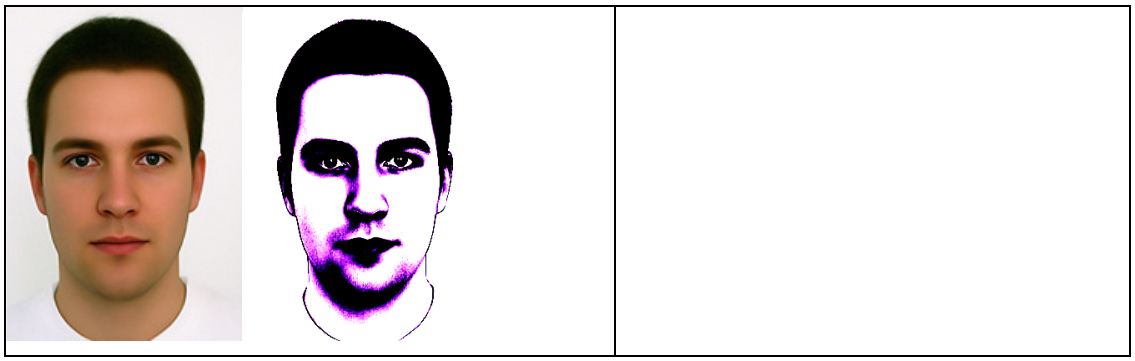


FIGURE 15: Results when some warping algorithms are omitted

6. CONCLUSION

In this paper, an enhanced warping algorithm is devised based on the basic pixel and image warping techniques. The right proportion of any basic technique will yield a very good finish. At first, the use of basic warping and pixel manipulation techniques seemed trivial. However, as they were mixed in several proportions, an exquisite result appeared. Caricature is used in many sphere of life. To build well- defined caricatures appropriate warping techniques should be used. Nowadays, we can make a portrait of ourselves in just a click of a mouse. When we knew how edges and contrast were related, using the right techniques in the right proportions allowed us to exploit this aspect of face image, which yielded to caricature.

7. REFERENCES

[1] Wolberg, G., Recent advances in image morphing, International presentation of Computer Graphics, June 1996, Pohang, Korea.

[2] Mikkel B Stegmann, *Image Warping* Informatics and Mathematical Modelling, Technical University of Denmark, DTU, October 2001

[3] Stoffels S., "Full mesh warping techniques", Proceedings of the COST G-6 Conference on Digital Audio Effects (DAFX-00), Verona, Italy, December 7-9,2000.

[4] Glasbey C.A., Mardia K.V., "A review of image warping methods", Journal of Applied Statistics, 25, 155-171, 1998.

[5] Gooch B., Reinhard E., Gooch A., "Human facial illustrations: Creation and psychophysical evaluation", ACM Trans. Graph., 23(1), pp. 27–44, 2004.

[6] Liang L., Chen H., Xu Y-Q, Shum H-Y, "Example-based Caricature Generation with Exaggeration", IEEE Proceedings of the 10th Pacific Conference on Computer Graphics and Applications, 2002.

[7] J.Shyh-Kang, "Audio Signal Processing-Quantization", Department of Electrical Engineering/ Graduate Institute of Communication Engineering.

[8] X. Bing, Y. Wei and C. Charoensak, "Face contour tracking in video using active contour model", School of Electrical and Electronic Engineering, Nanyang Technological University, IEEE 2004.

[9] Chiang P-Y, Liao W-H, Li T-Y, "Automatic Caricature Generation by Analyzing Facial Features", 2004 Asian Conference on Computer Vision, Korea, Jan 27-30, 2004.

[10] Chen H., Xu Y., Shum H., Zhu S., and Zheng N., "Example based facial sketch generation with non-parametric sampling", ICCV01, pages II: 433–438, 2001.

[11] Freeman W. T., Tenenbaum J. B., and Pasztor E., "An example-based approach to style translation for line drawings", Technical Report 11, MERL Technical Report, Cambridge, MA, Feb 1999.

[12] Nguyen K. H. L, Yong P. W., Golam A., "Shape Stylized Face Caricatures", School of Computing, National University of Singapore.

[13] Wen P., Wu, X., Huang W., Ren R., "An image warping method based on level set", 2nd InternationalCongress on Image and Signal Processing, Pg. 1569-1573, 2010