# 2D Image Morphing using Pixels based Color Transition Methods

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## ABSTRACT
Image morphing is the construction of an image sequence depicting a gradual transition between two images, has been extensively investigated now a days. 2D image morphing adds animations to the silent photographs which generally communicate limited information. The color transition method used in image morphing decides the quality of the intermediate images generated by controlling the color blending rate. If the color blending is done uniformly throughout the morphing process, good morph sequence is generated. Morph sequence has earlier morphs similar to source and last morphs similar to the target image. The middle image in the entire morph sequence is neither source nor the target image. Hence the quality of morphs depends on the quality of middle images. If it look good then entire sequence looks good. In this paper methods of color transition by averaging the pixels and by merging the color difference between pixels are proposed. The later one generates better quality middle image and entire morph sequence than most commonly used cross dissolve method of color transition.

## General Terms
Algorithm, Experimentation

## Keywords
Color Transition, Cross Dissolve, Gaussian Function, Active Shape Model (ASM), Triangulation, Pixel Transformation

## 1. INTRODUCTION
Image morphing is an animated seamless transformation of source image to the target image. It is used as a powerful tool for achieving special visual effect in the entertainment and film industry. It is basically an image processing technique used for the metamorphosis from one image to another. The idea is to get a sequence of intermediate images which when put together with the original images would represent the smooth change from one image to the other.

Two images can be easily morphed by cross dissolving the images. This gives an effect of fading out the source image and fading in destination image, so not effective actually. In addition during face image morphing the double exposure effect in the eyes and mouth areas is seen and morph does not look natural. So to get smooth and effective transformation of images three steps are required [1].

1. Control points extraction
2. Wrapping source image with respect to target image
3. Blending colors using color transition methods

The first and important step is to extract the control points or landmarks to be used when the image is being warped for e.g. in face morphing the landmarks would be from eyebrows, eyes, nose tip and mouth. Image wrapping can be defined as a method for deforming a digital image to different shapes [2].

Once the pixels are in position the color transition method used blends the colors of wrapped image with other one and hence transforms one image into another [2]. During color transition, color of each pixel is interpolated over time from the first image to the corresponding pixel value in second image [3].

For color transition mostly cross dissolve or one dimensional Gaussian function based methods are used. In cross dissolve number of intermediate frames generated is weight dependent i.e. weights are required to be adjusted depending on number of frames required. One dimensional Gaussian function based color transition method takes more computation time [2].

In this paper first the color transition by averaging the pixels in source and target images is discussed which does not give smooth transition. Hence a new color transition method based on color difference in the pixels of source and target digital images is proposed in this paper. In this method number of frames used is variable and every morph generated fuses the color difference and source image changes to the destination image smoothly. And this proposed method is compared with existing cross dissolve [10] method of color transition.

## 2. RELATED WORK
Before the image wrapping was introduced image morphing was achieved through the cross-dissolve of images, where one image is faded out and other image is faded in but this is not so effective in signifying the actual metamorphosis [1]. The results are poor; owing to the double-exposure and ghosting effect apparent in misaligned regions i.e. in face images generally it is most prominent in the eyes and the mouth regions. This was due to misaligned mouth and eyes regions in face. Over the past few years many image morphing techniques have been proposed. Effectiveness of the image morphing lies in the feature point selections and wrap generation.

Morphing human faces with automatic control point's selection and color transition [2] discuses use of combination of a face detection neural network [4], edge detection and smoothing filters. A triangulation method is used as the warp algorithm [5] while a method based on the one dimensional Gaussian function is applied in color transition control or blending of wrapped images.

A prototypical Automatic Facial Image Manipulation system (AFIM) for face morphing and shape normalization (warping) is proposed in [6]. In this AFIM system, the feature points are extracted automatically by using active shape model (ASM) [7] or extracted manually. Image wrapping is done using mesh wrapping [8]. And then blending of the wrapped images is based on cross dissolve.

Image morphing based on the pixel transformation is proposed in [9] and is mainly for blending two images without wrapping. In this pixel based morphing is achieved by the replacement of pixels values followed by a simple neighboring operation. Here the technique is to group the pixels in three categories and the applying neighboring operation on the three pixels each from the three categories to get intermediate image. This method is restricted for the gray scale (PGM) images only.

# 3. EXISTING COLOR TRANSITION METHODS

Third step of an effective image morphing called as color transition, decides the rate at which the pixel color blending to be done across entire morph sequence. This rate directly determines quality of morphs. One of the existing color transition methods is discussed here.

## 3.1 One Dimensional Gaussian Function

One method is using one dimensional Gaussian function for calculating weights [2]; which decides the rate of color blending. Given two corresponding target and source pixels, first difference in color between these pixels is computed and then setting the Gaussian function to 1 for the target pixel and to 0 for the source pixel weight for each morph in the sequence is calculated based on the color difference calculated before, the value of the Gaussian function at that point and the number of morphs required in the sequence. The color for each image in the morph sequence is given by equation (1).

$$\boldsymbol{\beta_j = \beta_i - \alpha_i * \Delta\alpha_{ij}} \qquad (1)$$

Where $\beta j$ is the color for the new pixel in an intermediate image, $\alpha i$ is the weight and $\Delta\alpha ij$ is the color difference between target and source pixels. This practice is repeated for every pixel in the image and for every intermediate image in the morph sequence. Finally the source image slowly changes to target image. Despite the fact that this method produces good morphs, it takes large computation time.

Here $\alpha$ is the weight which lies between 0 and 1, $0 \leq \alpha \leq 1$.Though
it is simple to implement, number of intermediate frames vary with weight $\alpha$ i.e. it depends on step increment of $\alpha$.

# 4. PROPOSED METHOD

## 4.1 Color transition by averaging the pixels

In this method of color transition the every pixel in intermediate image is average of the source image pixel and target image pixel from the same location. Certain iterations are performed to get morphs till RMSE value computed on the last morph generated and target image reaches to the threshold value. Every iteration generates new morph and for next iteration it acts as a source image.

**Algorithm:**

1. Start
2. Read two images A and B.
3. Resize both images to size M X N pixels.
4. Compute average of corresponding pixels in image A and image B.
   $C(i, j) = [A(i, j) + B(i, j)] / 2$
5. Compute RMSE of image C and B.
   $RMSE = \sqrt{\sum (C(i, j) - B(i, j))^2 / (M * N)}$
6. If RMSE value < Threshold value
   Break.
   else
   Display image C as an intermediate image.
   A = C
   Repeat the steps 4 to 6.
7. Stop.

This method generates morphs which are like target image only. No morphs like source are generated here and so the morph sequence is not balanced.

Main disadvantage of this method is that if the threshold RMSE value is not decided and simply averaging is carried out then too many frames which are nearly same as target are generated. Actual blending and the transition from source to target image is achieved in almost three to five morphs. Hence for the required number of frames the threshold is required to be fixed. Since the morph sequence is not balanced even if the morphs generation is of less complexity the transition from source to target image is not seamless.

## 4.2 Color transition by merging color difference in the pixels

This method is an improvement to method given in section 4.1. In this method balanced sequence of the intermediate images is generated and the number of morphs is controlled by user. No threshold is required here. This method can be compared with existing cross dissolve method of color transition discussed in section 3.2, when the number of intermediate images is in the range of 3 to 15. Weights required to control the rate of blending are computed using difference in the color of two corresponding pixels from source and target images and the number of intermediate frames required.

**Algorithm:**

1. Start
2. Read two images A and B.
3. Read number of frames F.
4. Resize both images to size M X N pixels.
5. Compute color difference D, pixel wise using steps 6 to11
6. If $A(i, j, k) < B(i, j, k)$
   $D = B(i, j, k) - A(i, j, k)$
7. Compute step size S as
   $S(i, j, k) = D / F$
8. If $A(i, j, k) > B(i, j, k)$
   $D = A(i, j, k) - B(i, j, k)$
9. Compute step size S as
   $S(i, j, k) = -(D / F)$
10. If $A(i, j, k) = B(i, j, k)$
    $D = 0$
11. Compute step size S as
    $S(i, j, k) = 0$
12. For 1 to F repeat step 13 and 14
13. Compute intermediate image as
    $C(i, j, k) = A(i, j, k) + S(i, j, k)$
14. Display intermediate image C.
15. Stop.

In this method computation of weights and deciding step size is simple and can be done in faster manner. Also generating intermediate image requires simple addition operation. The quality of morphs is good and hence when represented one after other as an animation seamless transition of two images than the one given in section 4.1 and cross dissolve is obtained.

## 5. RESULTS AND DISSCUSSTION

The implementation of cross dissolve, an existing color transition
Method [10] and new color transition methods, one by averaging pixels and other by merging the difference the values of corresponding pixels, is done in MATLAB 7.0 using a computer with Intel Core2 Duo Processor T4400 (2.20 GHZ) and 2GB RAM. The algorithms are tested on the face images of humans, flowers and animals. For all the results five intermediate frames are considered.
For cross dissolve method the value of α varies from 0 to 1. In the morph sequence generated by cross dissolve first image is always source image as α=1 and last image is always target image as α=0 so 1-α=1[10].

For color transition by averaging for five intermediate images threshold RMSE value is taken as two. This method generates the morphs which do not show the smooth changes as all the morph generated are like target image.

The proposed method of color transition given in 4.2 generates the morph sequence excluding source image and target images. Last image in this morph sequence is close to the target image. Hence for same number of frames we always get two additional intermediate images compare to cross dissolve method, which give the smooth effect to the transformation.

Figures 1, 4, 7, 10 shows the intermediate images obtained by morphing two images of human faces, flowers, animal and human and animals respectively using pixel averaging method.

Figures 2, 5, 8, 11 show the intermediate images obtained by morphing two images of human faces, flowers, animal and human and animals respectively using cross dissolve method.

Figures 3, 6, 9, 12 show the intermediate images obtained by morphing two images of human faces, flowers, animal and human and animals respectively using proposed method.

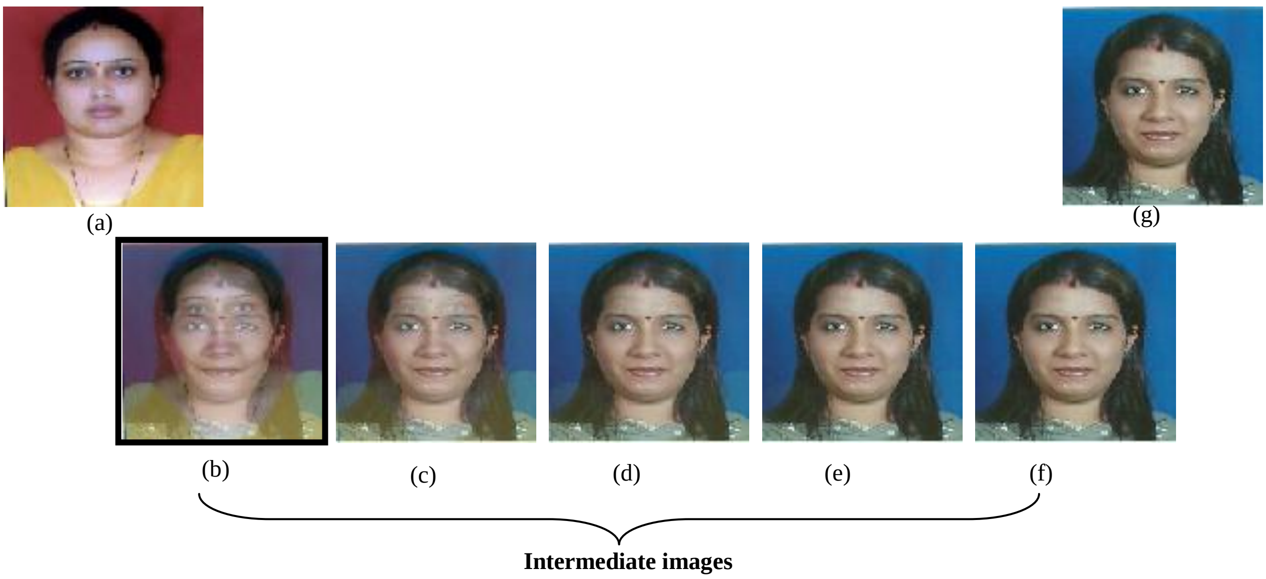



**Fig 1: Morph sequence obtained using color transition by pixels averaging for two human face images (a) Source image, (b) to (f) intermediate images and (g) Target image.**

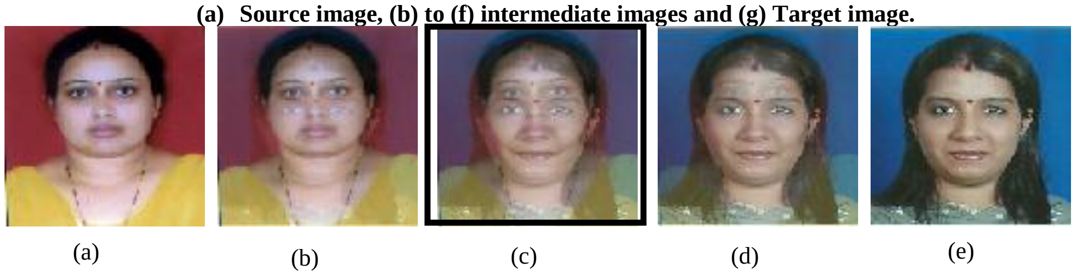



**Fig 2: Morph sequence obtained by cross dissolving two human face images (a) Source image or Morph1 with α=1, (b) Morph2 with α=0.75, (c) Morph3 with α=0.50, (d) Morph4 with α=0.25 and (e) Target image or Morph5 with α=0.**

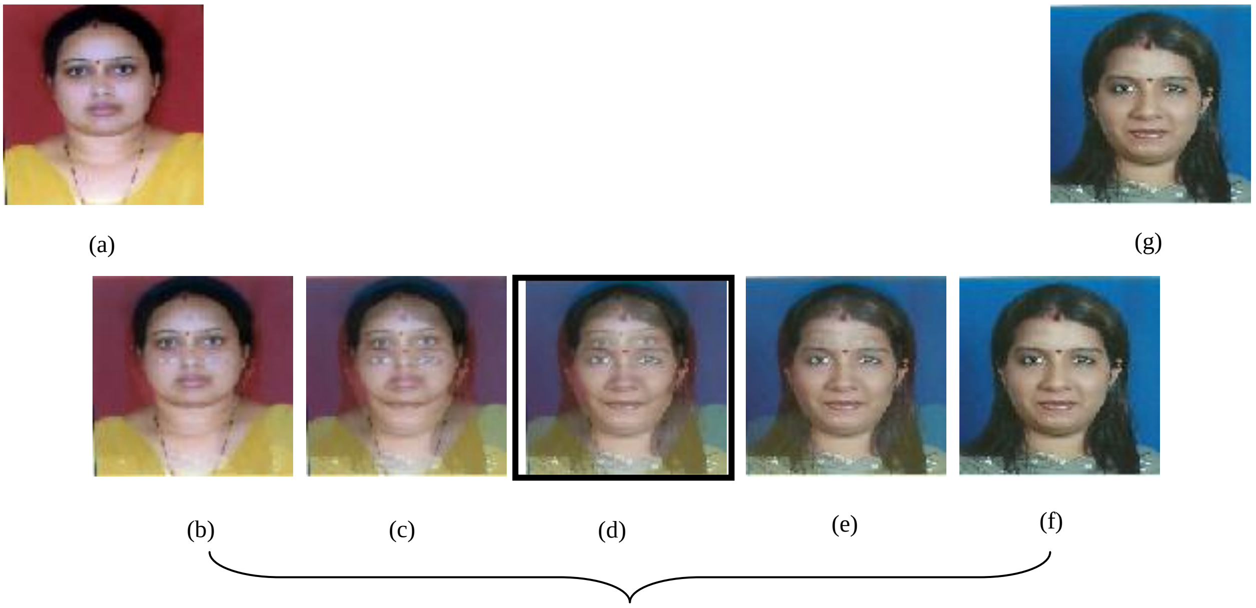



**Fig 3: Morph sequence obtained using color transition by merging the difference in colors of pixels for two human face images (a) Source image, (b) to (f) intermediate images and (g) Target image.**

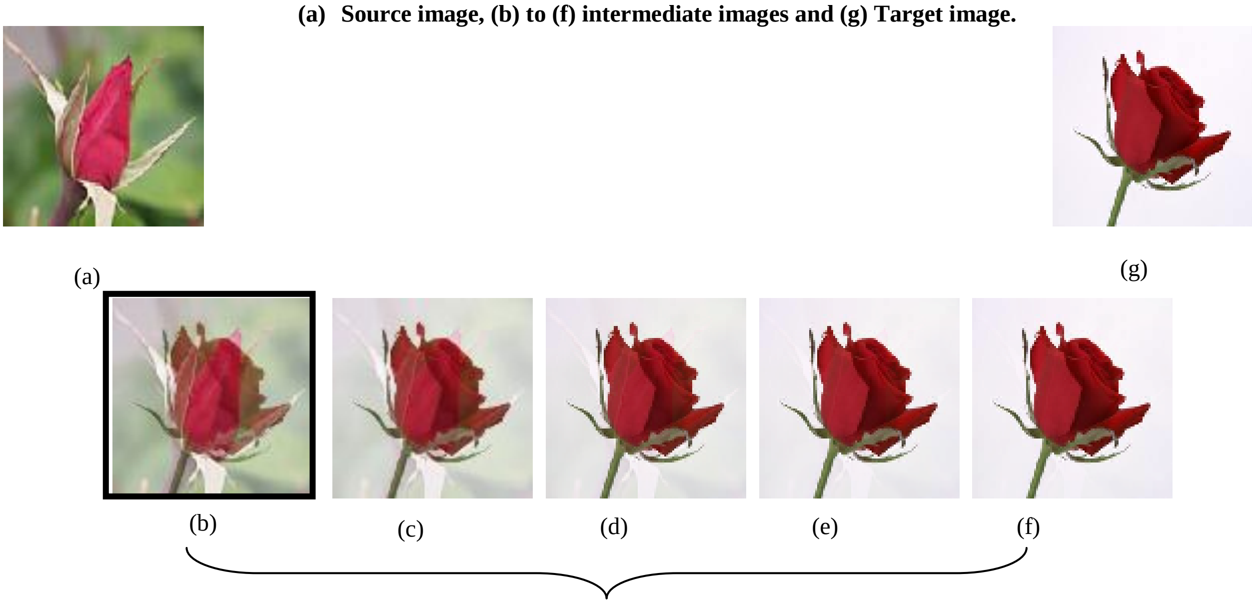



**Fig 4: Morph sequence obtained using color transition by pixels averaging for two rose images Source image, (b) to (f) intermediate images and (g) Target image.**

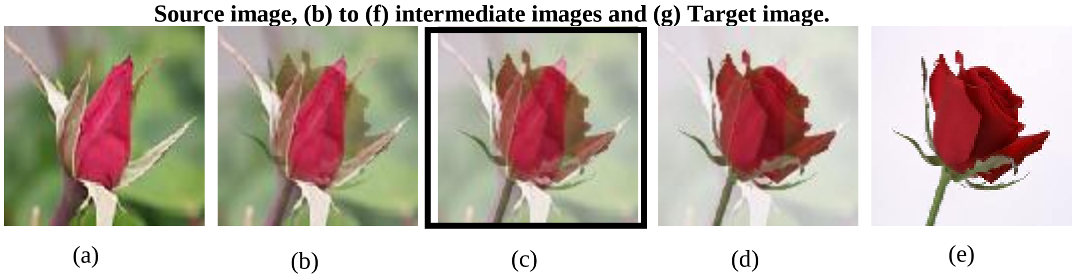
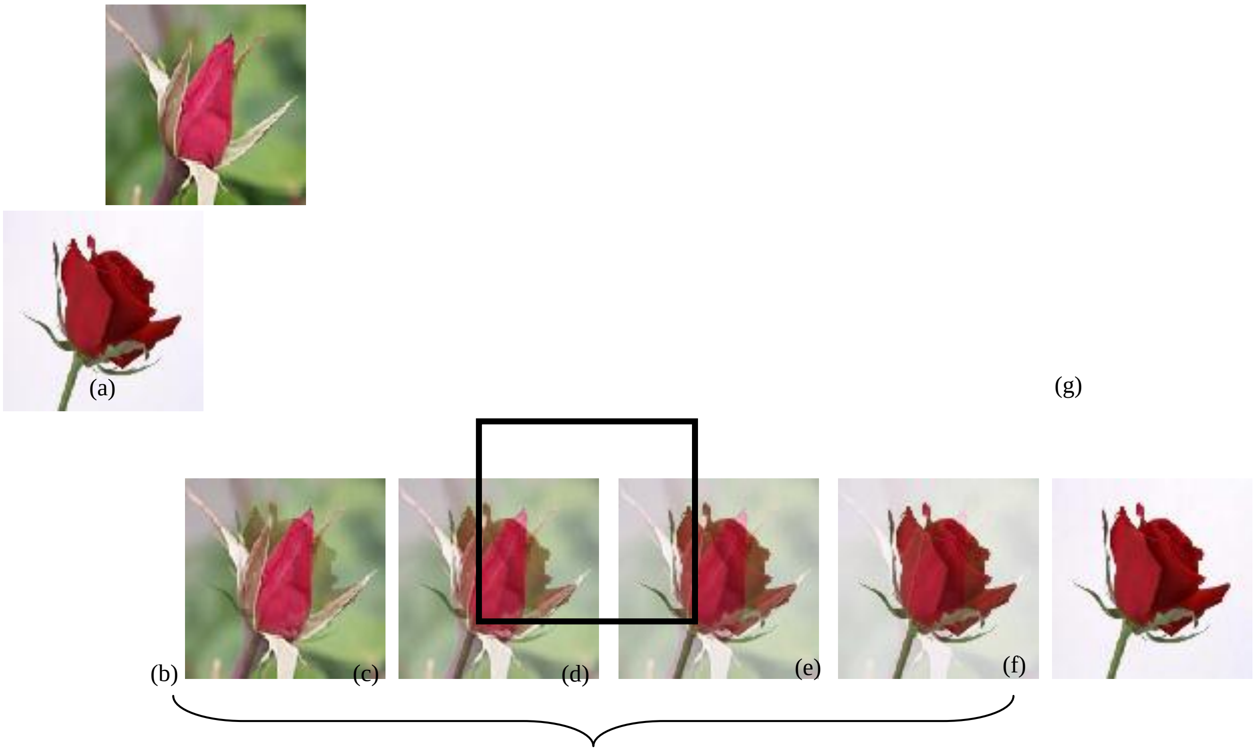



**Fig 5: Morph sequence obtained by cross dissolving two rose images (a) Source image or Morph1 with α=1, (b) Morph2 with α=0.75, (c) Morph3 with α=0.50, (d) Morph4 with α=0.25 and (e) Target image or Morph5 with α=0.**




**Intermediate images**

**Fig 6: Morph sequence obtained by merging the difference in colors of pixels for two roses (a) Source image, (b) to (f) intermediate images and (g) Target image**.


**Intermediate images**

**Fig 7: Morph sequence obtained using color transition by pixels averaging for animal and human face images** (a) **Source image, (b) to (f) intermediate images and (g) Target image**.


**Fig 8: Morph sequence obtained by cross dissolving animal and human face images (a) Source image or Morph1 with α=1,**

(b) Morph2 with α=0.75, (c) Morph3 with α=0.50, (d) Morph4 with α=0.25 and (e) Target image or Morph5 with α=0.

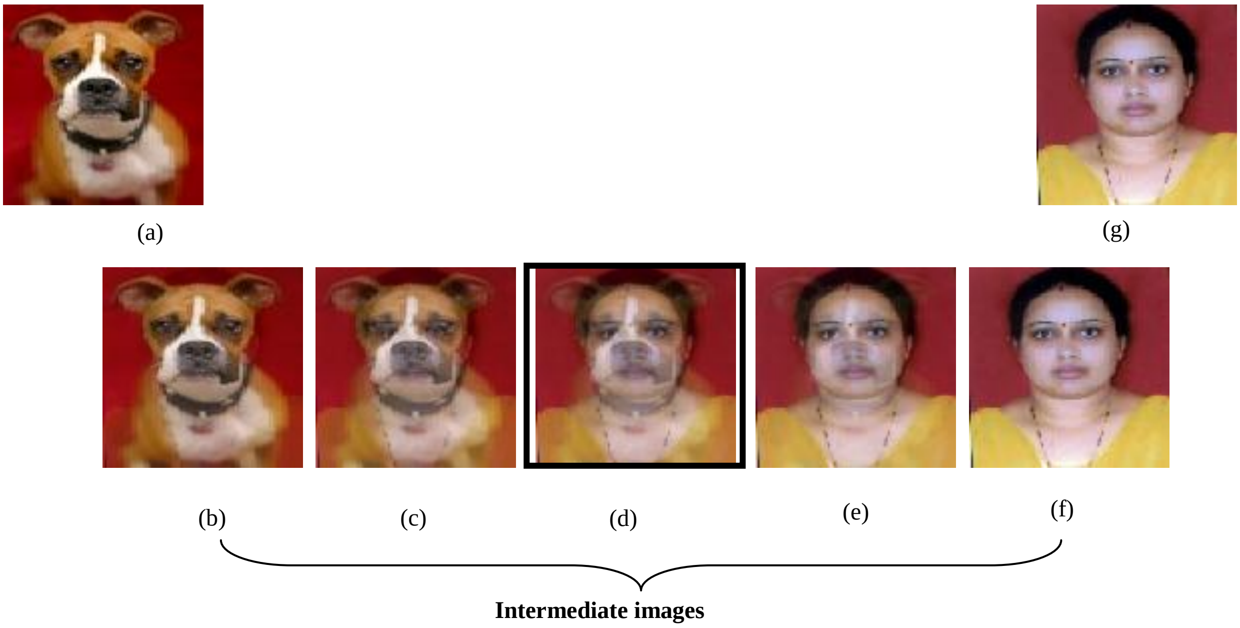



**Fig 9: Morph sequence obtained by merging the difference in colors of pixels for animal and human face images (a) Source image,**
**(b) to (f) intermediate images and (g) Target image.**

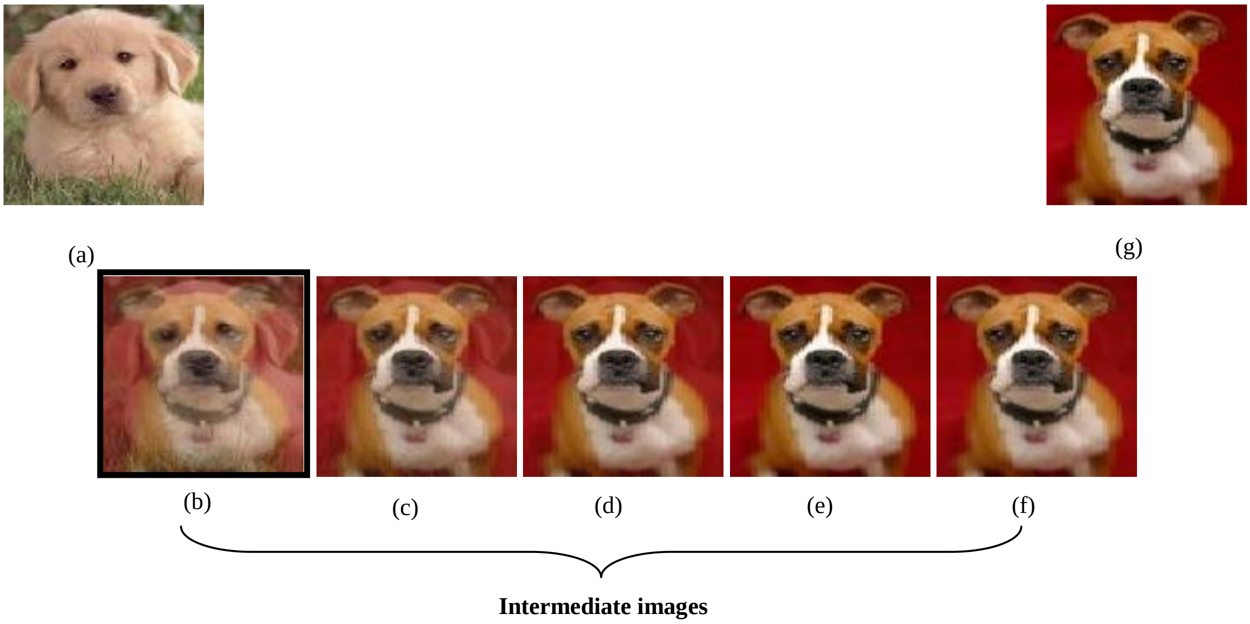



**Fig 10: Morph sequence obtained using color transition by pixels averaging for two animal face images**
**(a) Source image, (b) to (f) intermediate images and (g) Target image.**

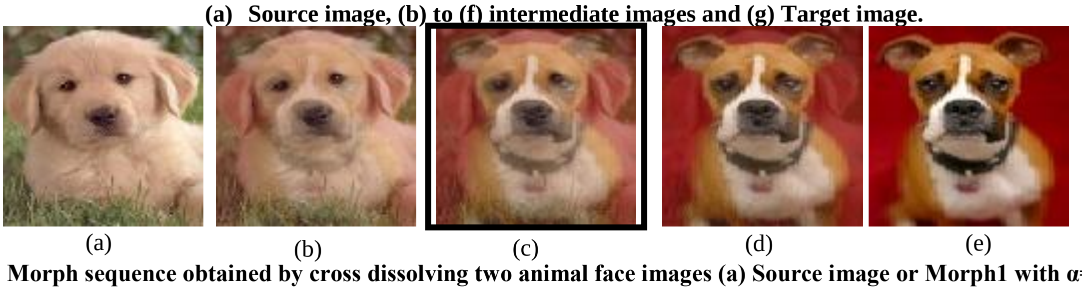



**Fig 11: Morph sequence obtained by cross dissolving two animal face images (a) Source image or Morph1 with α=1,**
**(b) Morph2 with α=0.75, (c) Morph3 with α=0.50, (d) Morph4 with α=0.25 and (e) Target image or Morph5 with α=0.**

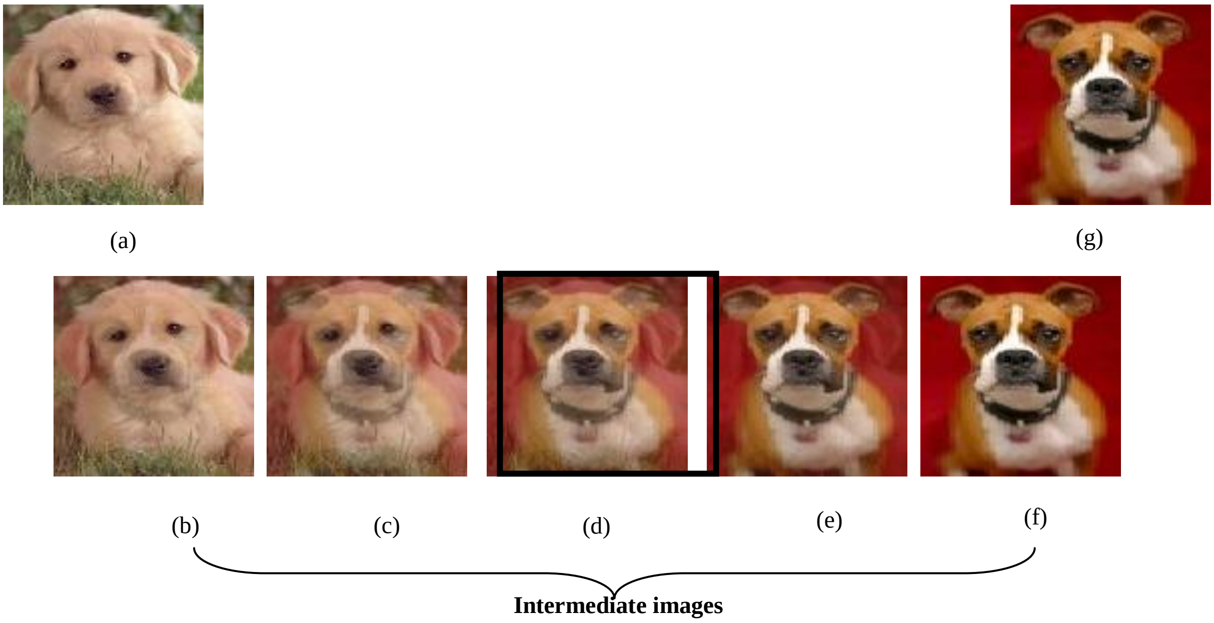



**Fig 12: Morph sequence obtained by merging the difference in colors of pixels for two animal images using (a) Source image, (b) to (f) intermediate images and (g) Target image.**

**Table 1: Comparison of root mean square error (RMSE) values obtained by last image and target image using Proposed color transition methods for five frames**

| **Image Category** | **Proposed Color Transition Methods** | |
|---|---|---|
| | **Averaging pixels** | **Merging the color difference between pixels** |
| Human faces | 2.78 | 1.41 |
| Human and animal faces | 2.50 | 1.41 |
| Roses | 3.76 | 1.40 |
| Animals | 2.75 | 1.36 |

**Table 2: Comparison of root mean square error (RMSE) values obtained by middle image and target image using Color transition methods Cross dissolve and merging the color difference between pixels for five frames**

| **Image Category** | **Color Transition Methods** | |
|---|---|---|
| | **Cross dissolve** | **Merging the color difference between pixels** |
| Human faces | 44.11 | 35.20 |
| Human and animal faces | 39.28 | 31.59 |
| Roses | 59.61 | 47.93 |
| Animals | 43.66 | 34.70 |

As it is seen from the results during morphing of two images the first image is gradually distorted and is faded out, while the second image starts out totally distorted toward the first and is faded in. Thus, the early images in the sequence are much like the source image. The middle image of the sequence is the average of the source image distorted halfway toward the final image and the final image source image distorted halfway back toward the first one. The last images in the sequence are similar to the destination image. The middle image is key; if it looks good then the entire animated sequence will look good.

In case of morphing by averaging all the morphs are like target and hence the sequence is not good there is abrupt transition from source to target image.

In this paper the firstly comparison of the quality of last morph generated by averaging pixel and by merging the difference in colors of pixels, for human face, flower, animal images is done using RMSE and is given in Table 1. From which it is clear that second method generated better last frame for same number of intermediate images.

Secondly comparison of the quality of middle image generated by cross dissolve and proposed method is done using root mean square error. Table 2 gives the root mean square error (RMSE) value calculated using middle image in the morph sequence and the target image for cross dissolve and second proposed method for human face, flower, and animal images. Hence from Table 2 it is clear that this method of color transition given in section 4.2 generates good quality middle image compare to cross dissolve method.

Even if the middle frame generated by averaging pixels is of good quality, as all the morphs generated are like target hence the transition does not gain the smooth effect.
Hence the quality of middle image in proposed method by merging color difference in pixels is better than the original cross dissolve for same number of the frames. Hence the transition is comparatively smooth.
Apart from this, figures 1, 2 and 3 where face images are used for morphing, the significant regions in face like eyes and mouth are misaligned. If these regions are aligned before using the proposed color transition method is applied the results will look natural.

## 6. CONCLUSION

Two simple color transition methods for 2D image morphing are proposed in this paper. Among which second proposed method is efficient and generates better quality middle image, last image, and entire morph sequence compare to the pixel averaging method of color transition. This method generates balanced source like and target like image which contributes to smooth transformation, whereas in pixel averaging generates all morphs like target image.

Second proposed method generates good quality middle image compared to the existing cross dissolve method of color transition. The advantage of this method over existing cross dissolves method is that computing step size is easy and number of intermediate images to be generated can be controlled by user, where as in existing cross dissolve method step size computation requires proper adjustments of the weights according to number of frames required.

In cross dissolve first frame is always source image and last frame is always target image. Whereas second proposed method always generates two extra frames and this contributes to seamless transformation. The RMSE value of middle image generated by second proposed method and target image is always less than that of cross dissolve method for same number of frames. It is nearly 0.8 times of the RMSE value of middle image generated by cross dissolve for five intermediate frames. Hence when number of intermediate frames is in between 3 to 15 the results of second proposed method are better than cross dissolve.

When the color transition method is used for face images of humans and animals, morphs generated does not look good due to the double exposure effect in significant regions in the face, like eyes and mouth regions. This is because even if both images are of same size the faces in both images need not be of same size and hence the eyes and mouth regions are misaligned which gives double exposure effect in morphs. Further work will be on 2D face image morphing for wrapping the source image with respect to the target image to align the significant features in face then to morph them.

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