MESH MORPHING FOR DENTAL CARIES

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ABSTRACT

In this paper, the mesh morphing technique is used to show the transformation of one digital image into another. First, mesh morphing is implemented in Matlab using its inbuilt functions as Delaunay triangulation etc.. Then its performance was evaluated on number of tooth images with caries to show visually the different stages of treatment. The work will help the patient to understand how the treatment will be done and how the tooth will look like after the treatment.

Keywords: Mesh Morphing, Image, Frames.

I. INTRODUCTION

Image morphing is the transformation of images. Morphing is an image processing technique used for the metamorphosis from one image to another. It is most often used in the movie industry with incredible special effects. Morphing is a powerful tool that can enhance many multimedia projects, presentations, education and computer based training. The idea is to get a sequence of intermediate images which when put together with the original images would represent the change from one image to the other. Mesh morphing involves the image processing techniques of cross-fading and warping. In this project the first image will be showing the specific problem in tooth, that is source image, and the target image is showing the treated tooth. In this the sequence of images are formed in between the source image and target image using the mesh morphing technique. Video of all the in between formed frames will show the transaction.

II. RELATED WORK

Michael Jackson's music video "Black & White" is one of the best examples of image morphing. Warping techniques have been discussed by Wolberg [1], including the popular thin-plate spline interpolation which is based on point correspondences. Zhengwen Fan et al. [2] have proposed a novel mesh morphing approach based on polycubic cross parameterization. They compose parameterizations over the surfaces of the polycubes whose shape is similar to that of the given meshes. Because the polycubes capture the large-scale features, used for easily preserving the shape of the models, mapping legs to legs, head to head, and so on. For the finer features that are not reflected by the shape of the polycubes, they split the polycubes into matching patches and optimize them to get a low-distortion bijection that satisfies user-prescribed constraints. Marc Alexa et al., [3] had worked on current technique, Mesh morphing technique is capable of producing a sequence of meshes, gradually changing from a source to a target shape; this do not allow describing the local behavior of the morph. A solution to this problem is presented. Marc Alexa et al., [4] summed up recent developments in the area of mesh morphing. It presents a consistent framework to classify and compare various techniques approaching the

same underlying problems from different angles. Jianwei et al. [5] have presented a novel morphing approach for 3D triangular meshes with the idea was to interpolate the mean curvature flow of the input meshes as the curvature flow Laplacian operator encodes the intrinsic local information of the mesh .

III. DENTAL CARIES

Dental caries is the medical term for tooth decay or cavities. It is caused by specific types of bacteria. They produce acid that destroys the tooth's enamel and the layer under it, the dentin (see Fig. 1).

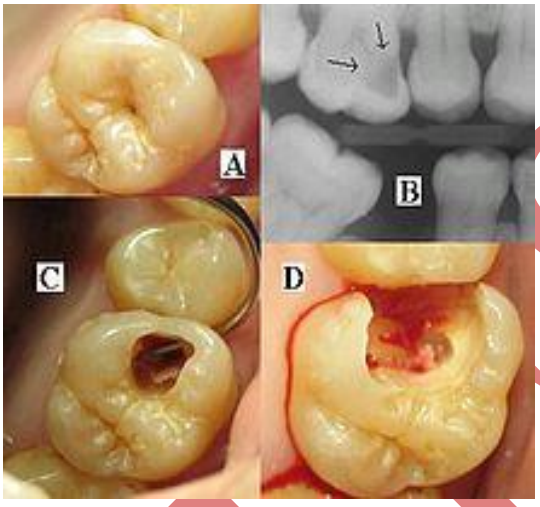


Figure 1: (A) A small spot of decay visible on the surface of a tooth. **(B)** The radiograph reveals an extensive region of demineralization within the dentin (arrows). **(C)** A hole is discovered on the side of the tooth at the beginning of decay removal. **(D)** All decay removed. Depending on the extent of tooth destruction, various treatments can be used to restore teeth to proper form, function, and aesthetics, but there is no known method to regenerate large amounts of tooth structure, though stem cell related research suggests one possibility [6]. Destroyed tooth structure does not fully regenerate, although remineralization of very small carious lesions may occur if dental hygiene is kept at optimal level [7].

IV. MESH MORPHING

The goal is the construction of a correspondence map between (S) and (D) (Fig. 2). Mesh morphing is a feature based metamorphosis technique. Meshes have become a widespread and popular representation of models in computer graphics. In mesh morphing we have two meshes: the source mesh with Ns vertices and the target mesh with Nt vertices (see Fig. 3).

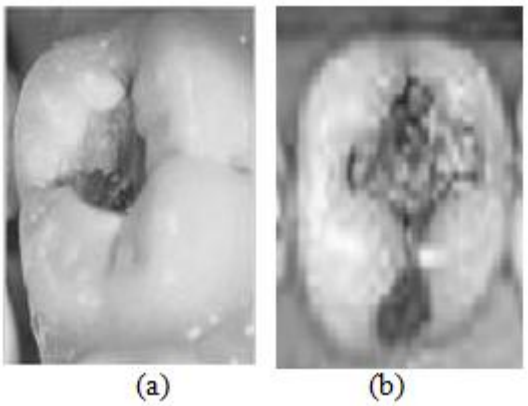


Figure 2: (a) A small spot of decay visible on the surface of a tooth, selected as source image, S and (b) the treated tooth image selected as final image, D.

In general, morphing algorithms consist of two processes: warping and combination or cross-fading. Cross-fade is the simplest possible way to produce a smooth transition from one image to another. At its most basic, cross-fading involves creating a series of frames composed of linear combinations of the two original images.

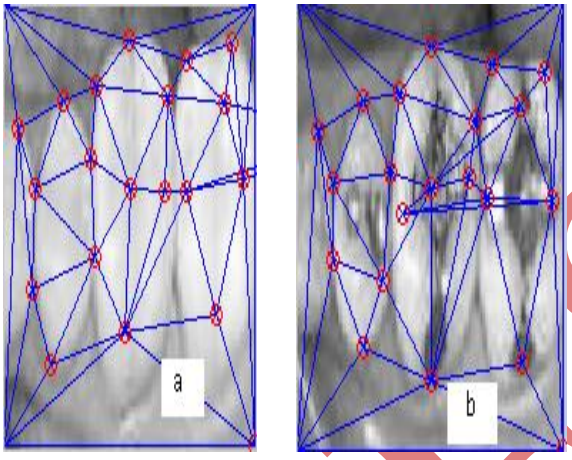


Figure 3: Shows triangular mesh on (a) source image and (b) destination images.

In mesh morphing, the features are specified by a non-uniform mesh.

V. PRESENT WORK

In this paper, Mesh morphing technique is developed which uses three steps:
(1) This algorithm uses original morphing technique formed by Smith [8]. It works in two steps that accept a source image and two 2D arrays of coordinates S and D (Fig. 3). The S coordinates represent the selected control pixels in the source image, and the D coordinates are the corresponding points selected in final image.

(2) The 2D arrays, in which the control points are stored, impose a rectangular topology to the mesh. In this morphing Delaunay triangulation [9] is used to sub-divide the images into a set of triangles. Instead of warping the entire image, each triangle is warped separately. Interpolation is warping each of the triangles pixels in the source image to appropriate position in the destination image, for this we are using the method of forming average mesh on both images which is calculated as:

$$[x,y] = (S-(S-D)*0.5)$$

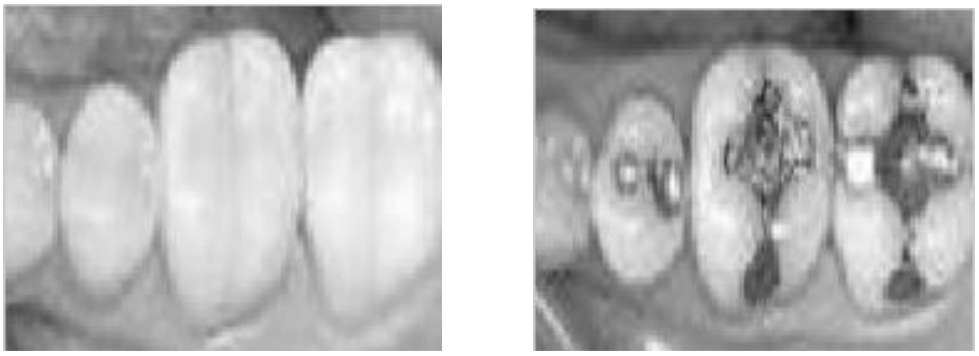
(3) Once both images are warped into alignment a cross-dissolve is generated between the two images. A cross-dissolve is merely an interpolation of pixel values. For a transition from grayscale image S to D with N frames, the intensity of a pixel at (x,y) in frame n is given by

$$F(x,y,n)=(n-1/N-1)S(x,y)+(N-n/N-1)D(x,y)$$ [8]

VI. RESULTS AND DISCUSSIONS

In this paper, the performance of proposed mesh morphing has been analyzed qualitatively. To test its performance, the algorithm is implemented in Matlab and experiments are performed on different set of equal sized source teeth images (Figs. 4(a) - 7(a)) and destination images (Figs. 4(b) - 7(b)). The proposed mesh morphing is applied on image1 to image4 (pl. see Figs. 4 to 7). The output of the proposed mesh morphing is the

sequence of intermediate images presented in Figs. 8(b-i) to Figs. 11(b-i). From the results, it is concluded that proposed method has rendered a smooth, real-time transition between source and destination images.

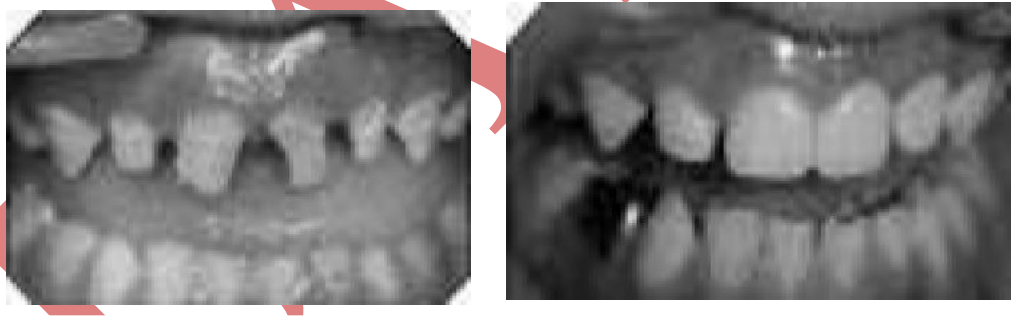


(a) (b)

Figure 4: Source image1 (a) and destination image (b) for dental cavities before and after treatment.

(a) (b)

Figure 5: (a) Source image2 (b) destination image for dental cavities before and after treatment.



(a) (b)

Figure 6: (a) Source image3 (b) destination image for dental cavities before and after treatment.

(a) (b)

Figure 7: (a) Source image4 (b) destination image for dental cavities before and after treatment.

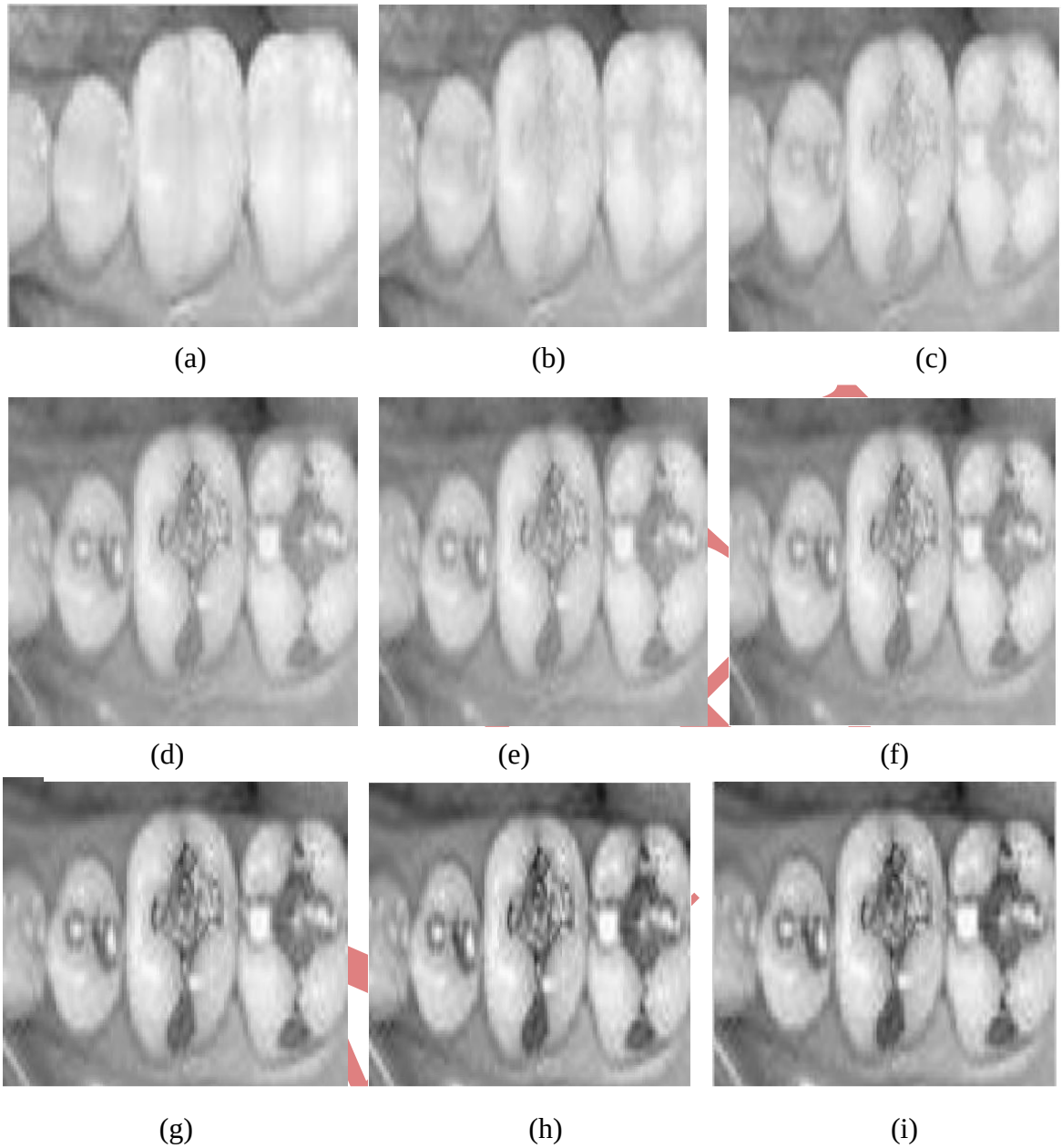


Figure 8: Images from (b) to (i) show the sequence of frames generated by applying morphing on source image1 to show video.

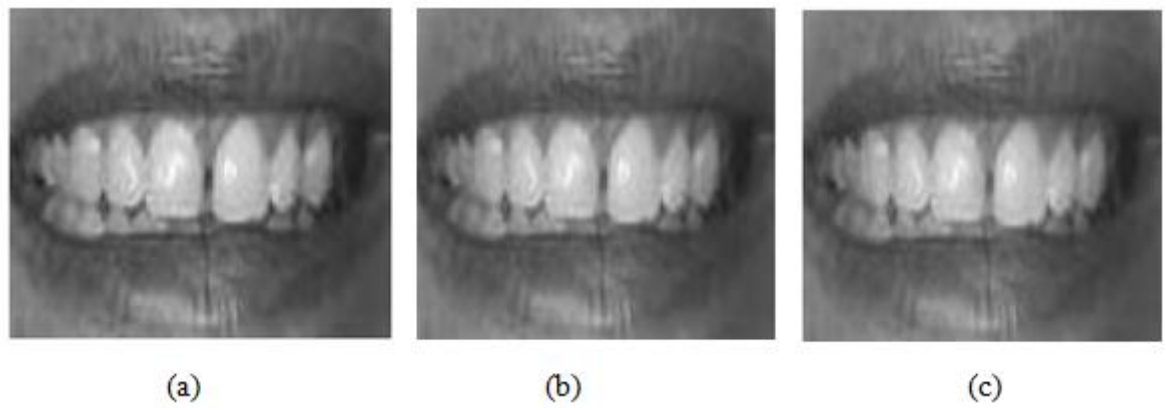


Figure 9: Images from (b) to (i) show the sequence of frames generated by applying morphing on source image2 to show video.

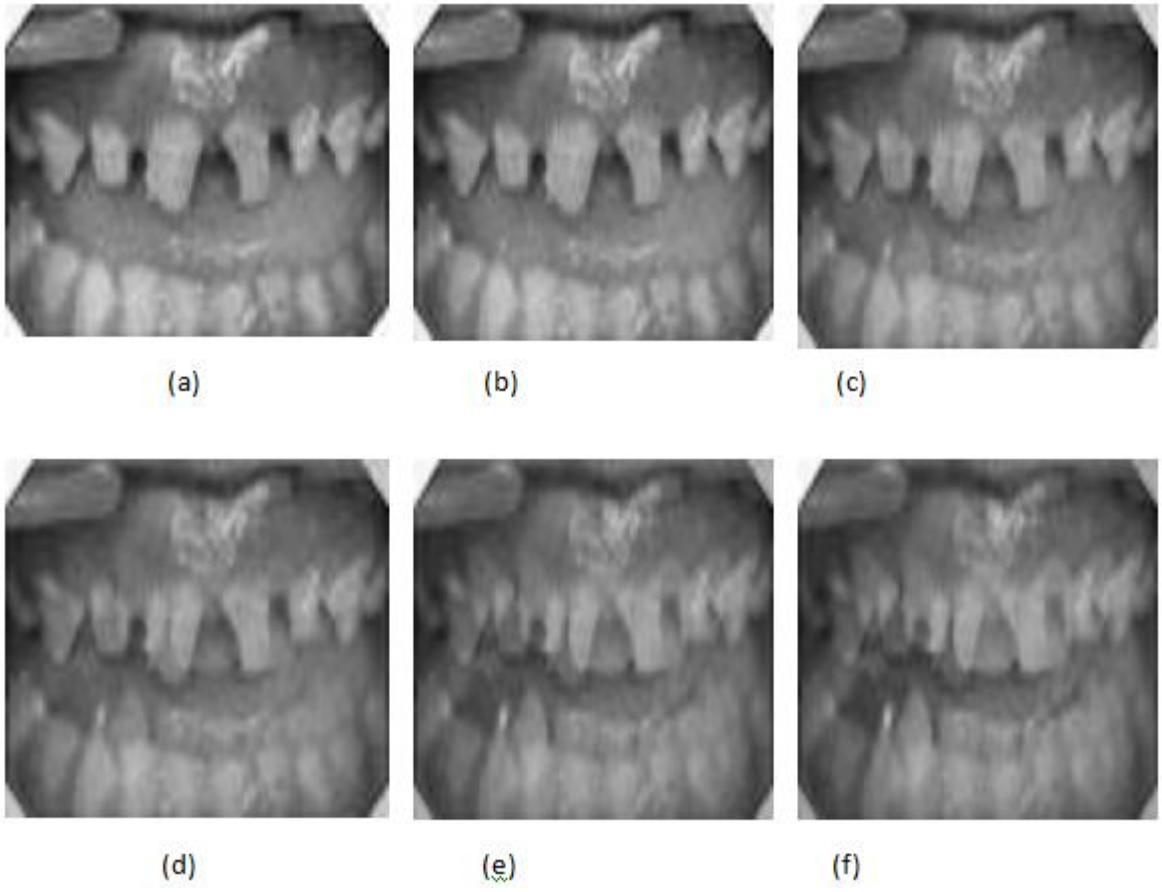


Figure 10: Images from (b) to (i) show the sequence of frames generated by applying morphing on source image3 to show video.

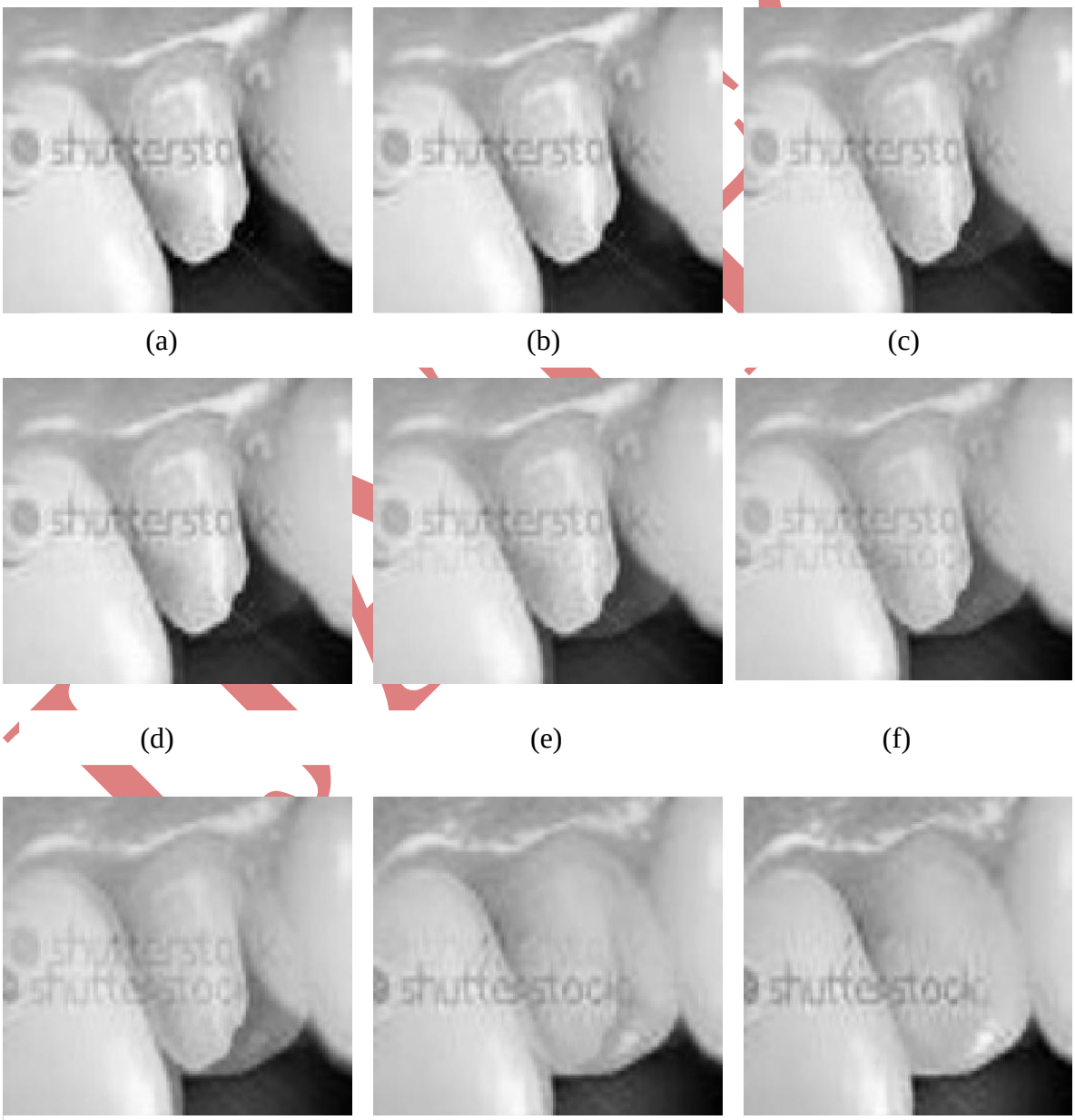


Figure 11: Images from (b) to (i) show the sequence of frames generated by applying morphing on source image4 to show video.

VII. CONCLUSIONS

The mesh morphing technique has worked well for dental caries. The algorithm needs two equal sized images (source and final) and marking of corresponding points on the images. The efficiency of the algorithm depends on how accurately points are marked. The technique yields a sequence of intermediate images depicting the different stages of treatment, starting from source to destination image. With the help of these images the video can be formed, which will help the patient to understand treatment.

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