Restoration of Historical Wall Paintings: A Review

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Abstract--- Wall paintings are esteemed symbol of our culture and history so, there is a need to preserve them. Restoration wall painting is a process of recover the wall paintings which are corrupted by many natural phenomena like unfavorable weather conditions, dust, smoke etc. due to which the wall paintings affected by many problems like cracks. Cracks are most frequent occurs in the old wall paintings. Walls which are decorated with paintings no longer survive so there is a need to preserve them. In this paper I have reviewed various techniques which are used to restore wall paintings.

Keywords: Digital Image processing Restoration, Historical Wall paintings, color restoration, cracks.

I. INTRODUCTION

Wall painting restoration is the process of restoring old and damaged wall painting which have cracks, fold marks ,dark or white spots etc. back to their original or a near-original state.Restoration of old wall paintings which are an esteemed symbol of culture and history so there is a need to preserve them so that future generations could see and learn from our culture. Wall paintings have been cultural expressions of human creation throughout history, from the earliest beginnings, such as rock art, extending up to present day murals. Their deterioration, accidental or intentional destruction constitutes a loss affecting a significant part of the world's cultural heritage. As a rule ,the old wall paintings no longer survive, since by collapsed together with their painted coat before the volcanic eruption , due to particularly strong earthquakes.[5]

The wall paintings are affected by many natural phenomena, like unfavorable weather conditions which cause destructive effects on the paintings. In dry environment, natural drying could lead to too rapid loss of water, resulting in non-uniform contraction and eventually in cracking. The cracks are frequent mostly in the wall paintings. The appearance of cracks on paintings deteriorates the perceived image quality [1].Dust ,smoke and other deterioration can further degrade the appearance of paintings. The result is that colors appear faint and the painting appears brown or black. This is particularly true for icons or church murals, where candle smoke degrades icon colors [2].

Color fading is common problem in the old wall painting almost every color has faded to some extents [11].So there is a need to restore the color of painting which is faded. To improve the overall quality of the image, there is a need to improve or enhance the color of image. By using the different types of color encoding techniques it can enhance the color of wall painting and remove the local deformities in the wall paintings.

The spots at which pixels have lost their color and turned to white values in the old paintings is also the problem in the wall paintings. There are many other problems occurs in the wall painting like folding lines, scratches which degrade the quality of the wall paintings. So there is a need to recover paintings which are affected by such problems.

Restoration is a process of recover an image which is degraded linear degradation. Paintings such as oil paintings can lose some points on the image to white spots which are very important to be recovered to maintain the overall good visibility of the image. The different technology and methodology needed for the conservation and restoration of wall paintings, the specialization focuses on the specific procedures used during the conservation and restoration of wall paintings based on multi-disciplinary knowledge. Most frequently used algorithms for restoration of wall painting are –

A. Morpholgical Processing:

Morphological algorithm was proposed to detect missing areas and also incorporates edge information. In the case of cracks and small missing areas, finding their boundaries and grouping them is enough for their rough identification. To detect cracks morphological top- hat transformation. To fill these cracks the median or related filters in the neighborhood of cracks are used. [7]

B. Segmentation:

Image segmentation technique is used to depict initial and region border extraction. In restoration process, all the initially depicted Fragments are gathered, then clean each fragment in the lab, and reassemble each composition from its constituent fragments. Main motive of this process is to restore the reassembled wall paintings by detecting and filling in the missing parts. [5]

C. Inpainting

It is restoration technique that is used to repair damaged areas of wall paintings by filling-in their missing areas and cracks. Inpainting technique is classified as structure inpainting and texture inpainting. Structure painting is basically is used to define main parts of images like boundaries, edges etc.Texture inpainting is only used to define text data printed on the paintings.[9]

II. LITERATURE SURVEY

In 1998, Giakoumis, I., & Pitas, I. [1] presented a paper "Digital restoration of painting cracks". In this paper the authors have developed a method for the restoration of cracks. The local minima were detected by the top-hat transformation. In this paper two methods were used for filling the cracks, one was based on order statistics and another one was based on anisotropic diffusion. They remove the thin dark brush strokes, which were misidentified as cracks through the MRBF neural network.

In 2000, Pappas, M., & Pitas, I. [2] presented a paper "Digital color restoration of old paintings". This paper

presented techniques for restoration of color of old wall paintings. The various physical and chemical changes degrade the visual appearance of old paintings. For this purpose, the five color restoration methods (Mean sample matching, linear approximation, ICP approximation, White point transformation, RBF approximation) were used to simulate the original appearance of paintings. All methods have small computational requirements.

In 2001, Nikolaidis, N., & Pitas, I.[3] presented a paper "Digital image processing in painting restoration and archiving". This paper presented three applications of image processing. First was crack restoration of old paintings. Second was color restoration of wall paintings and third was mosaicing of partial images of works of art painted on curve surface. Crack detection was done by morphological top- hat transformation. Crack filling was done by applying the median or related filters in the neighborhood of cracks. A digital achieving system was also described in this paper.

In 2002,Papaodysseus, C., Panagopoulos, T., Exarhos, M., Triantafillou, C., Fragoulis, D., & Doumas, C.[10] presented a paper "Contour-shape based reconstruction of fragmented, 1600 B.C. wall paintings".In this paper a methodology is introduced for the reconstruction of the wall paintings of Greek island Thera (Santorini) which were painted in the middle of the second millennium B.C.According to this each fragment was photographed, its picture was introduced to the computer,its contours were obtained and all of contour fragments were compared.

In 2005, Papaodysseus, C., Exarhos, M., Panagopoulos, T., Triantafillou, C., Roussopoulos, G., Pantazi, A. & Doumas, C.[4] presented a paper "Identification of geometrical shapes in paintings and its application to demonstrate the foundations of geometry in 1650 BC.". The aim of this paper was to introduce an original general methodology to determine whether a handmade shape corresponds to a given geometrical prototype. To achieve this, three mathematical criteria are introduced, two of them being of statistical nature and the other one being based on fuzzy logic. The application of these criteria to the very important Late Bronze age wall paintings, decorating the internal walls of an edifice excavated at Akrotiri, Thera, shows that the spirals depicted on these wall paintings correspond to linear (Archimedes) spirals with exceptional accuracy.

In 2008, Papaodysseus, C., Exarhos, M., Panagopoulos, M., Rousopoulos, P., Triantafillou, C., & Panagopoulos, T.[5] presented a paper "Image and pattern analysis of 1650 BC wall paintings and reconstruction". In this paper color image segmentation method and pattern analysis was used in connection with the extraordinary 1650 B.C. wall paintings of the Greek island of Thera. They used color image segmentation methods to decay many problems and provide a very good approximation of the initial fragment depiction. Specific pattern matching techniques were used for the reconstruction of wall paintings.

In 2008, Pnevmatikakis, E. A., & Maragos, P. [9] presented a paper "An inpainting system for automatic image structure-texture restoration with text removal". In this paper the authors deal with inpainting problem and with the problem of finding text in images. The main focus of this paper was combination of the inpainting techniques with the techniques of finding text in images and simple morphological algorithm was used to link them. In this an automatic system is developed for text removal and image restoration that requires no user interface at all.

In 2009, Rousopoulos, P., Arabadjis, D., Panagopoulos, M., Papaodysseus, C., & Papazoglou, E.[6] presented a paper "Determination of the method of drawing of prehistoric wall-paintings via original methods of pattern recognition and image analysis".In this paper a method of construction of prehistoric wall painting was implemented. The approach consist of algorithms that perform preprocessing of the contours of the figures appearing in the wall painting, determination of patterns repetitions in the contours of the depicted entities, classification of these repeated patterns into proper geometric prototypes and curve fitting.

In 2012, Ding, H., & Ding, H.[8] presented a paper " Research on computer color recovery system for traditional Chinese painting". In this paper the authors developed manual and automatic computer Chinese painting's color recovery prototype system for the color recovery of Chinese paintings by using the digital image processing technologies and implement the basic functions by using programming tools such as VC++ and GDI+. In this color consistency problem is also resolved. Good color consistency result in digital restoration was achieved.

In 2013, Karianakis, N., & Maragos, P.[7] presented a paper "An integrated system for digital restoration of prehistoric Theran wall paintings". They implemented an integrated system which restores missing parts of various sizes and shapes that appear in Theran wall paintings.In this ,the missing area was stitched by applying the steamless image stiching algorithm and the total variation inpainting was used for area extraction and repair. The non-local inpainting mechanism was used for elimination of minor defects on the retrieved parts. The graph cuts were used for missing area with complicated boundaries.

III. CONCLUSION

Restoration wall painting is a process of recover the wall paintings which are corrupted by many natural phenomena like unfavorable weather conditions, dust ,smoke etc. due to which the wall paintings affected by many problems like cracks. This paper present various techniques for restoration of wall paintings and their comparison on the basis of their use in different applications and their advantages. A number of a digital image restoration techniques are used to recover the original apperance of the wall paintings but during this review I concluded that morphological processing is quite better as compared to other techniques.The advantages of Morphological algorithm is that, it is used to detect missing areas with complicated boundaries as well as incorporates edge information using iterated graph cuts. In future we are working on nearest neighbour algorihm for the restoration of the wall paintings to dectect and remove the cracks and white spots in the wall paintings.

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