Study Of Image Inpainting Based On Learning

Huaming Liu, Weilan Wang, and Xuehui Bi

***Abstract*—In this paper, we construct a actual system of image inpainting based on the image inpainting system model[1] which was proposed before, in order to repair more types, more broken images in the different field and restore them more efficiently ,because there is no one "universal" or more general algorithm can repair all types of images. The proposed system integrates the commonly used several typical algorithms, when using these algorithms to repair the image, adding some knowledge of human-assisted analysis to help users select the appropriate algorithm for image restoration. It is necessary that the broken images needs classifies subjectively and objectively before inpainting and the result of image inpainting needs estimate subjectively and objectively after inpainting. The estimation results of image repairing can analyze the advantages and disadvantages of the various algorithms; it can provide users with appropriate algorithms selected. This system also has the self-learning function to make the system more flexibility and practicability.**

***Index Terms*—Image inpainting, learning decision-making, inpainting system model**

I. Introduction

Digital image inpainting is an important issue in the domain of image restoration and an international interesting research topic in recent years. At present mainly two classifying-techniques can be found in the literature related to digital image inpainting. The first one deals with the small-scale deficient of digital image inpainting techniques. The technique was introduced into image processing by Marcelo Bertalmio, Guillermo Sapiro, Vicent Caselles and Coloma Bellester[2][3], using marginal information of damaged region, and essentially this is an inpainting algorithm base on partial differential equation(PDE). Another is image inpainting based on variation method [4~6] of the geometric image models, which simulate repair craftsman. These methods have essentially the link between them [7]. The second one is image completion based on texture synthesis fill-in the large damaged region. This technique includes two methods: one is to decompose image into structure part and texture part, where use inpainting algorithm to inpaint structure part, and use the method of texture synthesis fill-in texture part[8][9]; another is texture synthesis technique basing on patch, which selects a pixel in the border of the to be inpainted region, take the point as center, select a proper texture path in size by texture characteristic of the image, then look for the most similar texture matching patches around to be painted region to replace the patch[10].

The actual system of image inpainting, based on the image inpainting system model [1], was constructed. It integrates more typical image inpainting algorithms, repair the damaged region using different algorithms and estimate the result the inpainting through by subjective and objective estimation, then the result is stored in the information database. At the same time, the damaged region needs subjective and objective classification in the process of inpainting and classification results are recorded in the information database. In the actual inpainting, system also has intelligent decision-making module, which has a learning-self function, can carry on the statistics to the history records in the information database for seeking the most suitable image restoration algorithm. Therefore, system can provide the necessary information to the user when the repairing process, the user can select conveniently the appropriate algorithm for repairing the damaged region. Testing process and results show that the constructed system can achieve the desired results and user select the appropriate algorithms for image restoration.

II. INPAINTING SYSTEM

To be better understanding the repair system proposed in the paper, and the damaged images are Thangka and natural images, through the experimental analysis, it is studied that the system how to repair the damaged images using decision-making function in the learning-self modules.

A model of image inpainting system is proposed, as shown in Fig.1, we hopes to resolve the current shortcomings of various inpainting algorithms and can repair more damaged image better, according to the current situation of the image restoration. The proposed the learning-based model of image inpainting system can repair the damaged images, first, for the input images, we need to confirm what category (damaged Thangka are classified crease, rip, spot and others) damaged image is, parameter v1 denotes. The damaged image maybe has N damaged regions after segmentation. Then extracting the features of each damaged region around, using the classification algorithm, the damaged region can be classified, texture patches, edge patches or smooth patches, the parameter can be denoted to V2. After the types of the damaged region are identified, it

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can guide the user or system to select the appropriate inpainting algorithm, for each damaged region can be repaired adopting one or more algorithm. For the proposed the model, it integrate lots of inpainting algorithms, can get each algorithm's capability which is suitable for repairing what types of damaged region.V3 indicates the area of the damaged region. The parameter v4 is the serial number of one or more algorithms by order of the used algorithms, which may have one or more algorithms, and the sequence reflects the order of the used algorithms. The value of V4 changes, that the sequence of the used algorithms changes, will affect the values of V5, V6, v7 changing. After inpainting the system adopt the method of subjective estimation value of v5 and objective estimation the value of v6 and v7, finally receive three parameters, which present the inpainted effect. The value of v6 can be acquired by PSNR (Peak Signal to Noise Ratio) method and the value of v7 can be obtained by the chromatism evaluation method, reference the calculation in [1].

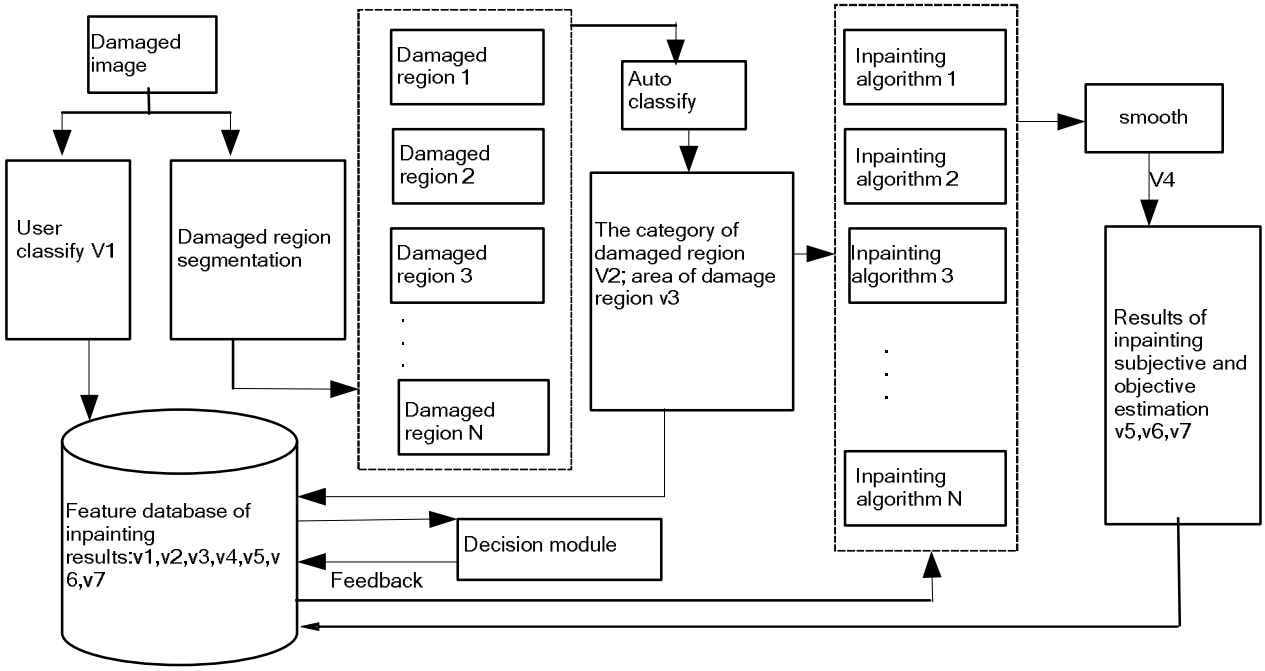

Fig 1. System model of image inpainting with subjective estimation and objective estimation integrated

Image inpainting is a very complex process, the case for the broken image appears, and repair process is different in the system. In this paper, the system constructed repair process can be described below.

Damaged region is unique in the image, which is only one damaged region. In this situation we can classify the damaged region using its characteristics (the characteristics of damaged region are based on it's around information, such as gray value, gray variance, gradient variance feature information, etc.), the damaged types are three categories: smooth patch, texture patch and edge patch. The classification result can help us to find suitable algorithms for inpainting. A variety of algorithms may be able to repair the damaged region well, but may be no algorithm can repair the damaged region, this situation is also very common.

Damaged regions are more than one in an image, and their shape and area, etc. are not identical, it is more difficult to inpaint the damaged region. Up to now, there are not systems or algorithms, which can repair the entire damaged region. In the paper, the constructed system attempt to repair the damaged region through selecting the appropriate algorithm after classifying the damaged region. In order to study this work conveniently, the damaged region is divided into three categories, smooth patch, texture patch and edge patch. If an image have three categories, and each of them can be inpainted by adopting appropriate algorithm, so it is very likely that repairing an image use more than one algorithms, that is very common and conforms to the actual repair process. When an image has N damaged regions, and each of them can adopting different algorithm, thus the sequences of repairing may be more possible, each algorithm in the sequence, it correspond to the inpainting of a damaged region. Therefore, the repair sequence is important, and it is stored in the information database, which can help researchers to analyze the inpainting algorithm. At the same time it is likely to happen that some damaged region cannot be repaired better, the reason is there is not appropriate algorithm to inpaint the damaged region in the system, these all require further study algorithm to solve this problem. The proposed system, cannot able to repair all damaged images, further study algorithms can be added to the system, so that it has a greater ability to repair. The characters of damaged region is a key issues considered, such as the area of damaged region, shape, around information, the location in the image etc,

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they will influence the result of inpainting, there are some characteristics used in our system, more characteristics will be used in the future study for improving the quality of the

III. LEARNING-SELF DECISION-MAKING MODULE OF SYSTEM MODEL

There is a learning-self decision-making module in the system model proposed, which can obtain the statistical information about the historical inpainting records, provide user with the records with high degree of satisfaction, it has some information about adopting inpainting algorithms and can be referred to help us to select the appropriate algorithms for inpainting in the process of inpainting.

Information database have image name, image data, artificial classification information value v1, categories value of damaged region v2, damaged area value v3, sequence value of inpainting algorithms v4, subjective estimation of the inpainting result value v5, objective estimation of the inpainting result values v6 and v7, and others, such as consuming time of inpainting.

The decision-making process of the system is that, firstly, user needs to classify the damaged region through around its characteristics of information (using gray-scale mean, gray-scale standard deviation, average gradient, gradient standard deviation and the number of the point within the gradient strength threshold) , damaged region can be classified using the classifier[11], the categories of the damaged region can be obtained; secondly, system help user to select appropriate algorithms based on similar historical inpainting records.

The system prompts to the user the decision-making information, is the historical records, which are selected algorithms and consuming time of inpainting and so on, at the same time the decision-making module offer preferentially the high degree of satisfaction inpainting result of similar damaged image for user selecting of algorithm. The results of the best records array top, according to the value F, where F= $0.8 \times V5+0.2 \times (V6+V7/100)$ weighted calculation. The subjective estimation value is the most valuable assessment; the objective estimation has a relatively small proportion, it conforms to people's satisfaction with the result and has strong reference. Users can provide examples of inpainting of historic records, view original damaged image and the inpainting result of damaged image, analysis disadvantage and advantage of adopting algorithm. For the similar damaged region can select algorithm adopted in the historical records, so that improve the effect of the inpainting.

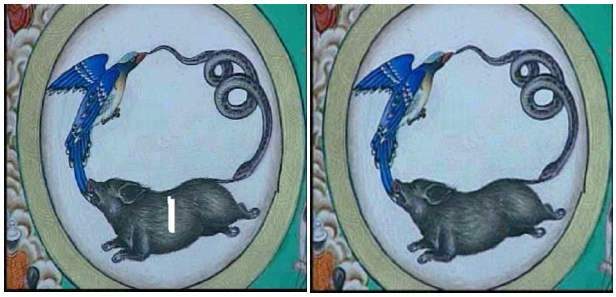
IV. THE INPAINTING RESULTS

Crease-Thangka image inpainting, its result is shown in the Fig.2 B image, and result is satisfactory. The damaged region is narrow in Crease-Thangka; edge line can be repaired well. When inpainting, and after segmenting damaged region, if the damaged region is texture patch, inpainting. Finally, the results of the inpainting need to evaluate in subjective and objective, and estimation results are stored in information database.

system will use learning-self decision-making module, which inquire in the historical records, according to the value of F, array the historical records about inquiring texture damaged region. Fig.3 and Fig.4 are the historical records. They used the algorithm, which can repair the damaged region, as shown in the Fig.2, the texture damaged region is very well. For the damaged region of natural images, as shown in Fig.5, its damaged region types is edge patch, system will provide a learning-self decision-making module, which inquires the historical records Fig.6 and Fig.7 ,according to the value of F, and using their inpainting algorithm, the result of inpainting is shown in Fig.5.

A.Crease-Thangka B.The result of repairing

Fig 2.The inpainting of Crease Thangka



A. Damaged Thangka B. the result of inpainting

Fig 3. Thangka inpainting

A.Damaged Thangka B.The result of repairing

Fig.4The inpainting of damaged Thangka

Through the above two examples, in the paper the system constructed can inpaint images well. At the same time the user select algorithm for inpainting, they can refer to the historical records, which can help user to adopt the algorithms and to avoid the blindness of the user selection algorithm.

V. CONCLUSION

In the study of Thangka image inpainting process, it is

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found that if use a single algorithm to repair damaged regions then inpainting the damaged categories are less. We are also actively trying to find "universal" algorithm, it is difficult to do it. In the paper, an inpainting system model is proposed and constructed, according to the current some inpainting algorithm that lacking universal defect. The system can not only repair the Thangka image, but also can repair other, such as natural images. The model integrates the various image inpainting algorithm, it can repair the damaged images based on algorithm advantages, which play their superiority, and make up other algorithm's defect, extend the function of a single algorithm. The system with learn-self decision-making module help users to select the appropriate algorithm for inpainting, avoiding the blindness of the user selection algorithm, improving the effect of inpainting. The proposed system model hope to give other researchers some inspiration in image inpainting, the system model realization will be set according to specific circumstances of the case. With the further study, more parameters probably need to be added so that supply the better decision-making for inpainting of damaged image

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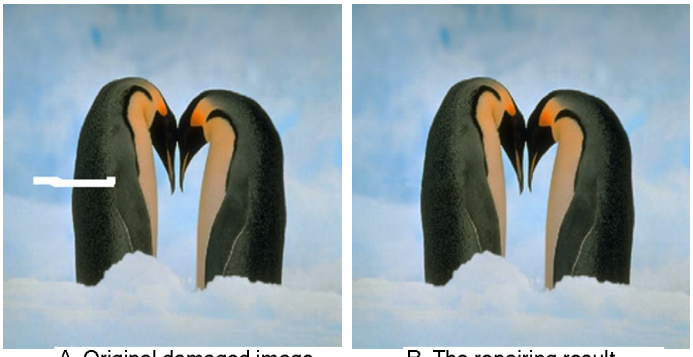
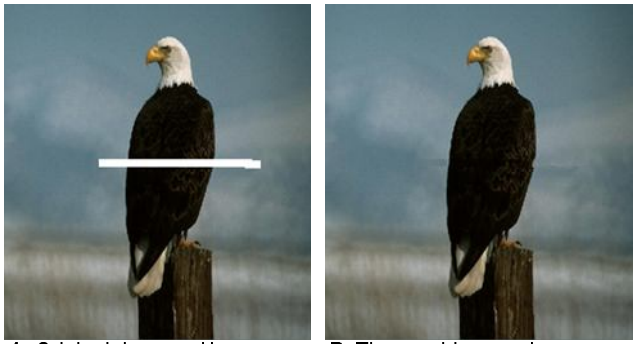
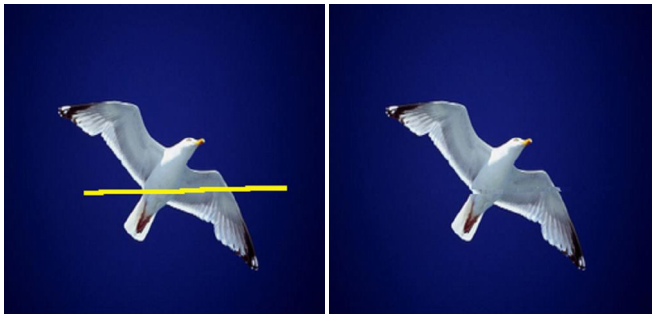


A. Original damaged image B. The repairing result
Fig 5. image inpainting



A. Original damaged image B. The repairing result
Fig 6. Image inpainting



A. Original damaged image B. The repairing result
Fig 7. image inpainting

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