

Research Article

A Poisson Equation-Based Method for 3D Reconstruction of Animated Images

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Received 8 September 2021; Revised 21 October 2021; Accepted 22 October 2021; Published 27 November 2021

Academic Editor: Miaochoao Chen

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3D reconstruction techniques for animated images and animation techniques for faces are important research in computer graphics-related fields. Traditional 3D reconstruction techniques for animated images mainly rely on expensive 3D scanning equipment and a lot of time-consuming postprocessing manually and require the scanned animated subject to remain in a fixed pose for a considerable period. In recent years, the development of large-scale computing power of computer-related hardware, especially distributed computing, has made it possible to come up with a real-time and efficient solution. In this paper, we propose a 3D reconstruction method for multivisual animated images based on Poisson's equation theory. The calibration theory is used to calibrate the multivisual animated images, obtain the internal and external parameters of the camera calibration module, extract the feature points from the animated images of each viewpoint by using the corner point detection operator, then match and correct the extracted feature points by using the least square median method, and complete the 3D reconstruction of the multivisual animated images. The experimental results show that the proposed method can obtain the 3D reconstruction results of multivisual animation images quickly and accurately and has certain real-time and reliability.

1. Introduction

With the development of computer image technology, the requirements for computer hardware are getting higher and higher. It is common to use 3D models to analyze industrial problems; three-dimensional acquisition and display technology advances also make the object with rich geometric. The need for model reconstruction techniques for 3D solids with rich geometric properties is growing [1]. The Poisson equation-based 3D surface reconstruction technique is used to study the algorithm for reconstructing a triangular surface model with solid geometric surface information of an object based on the existing 3D point cloud model with normal vector information. The steps of the algorithm include preprocessing the input point cloud information with normal vector information, discretizing the global problem, solving the discretized subdata, extracting the equivalent surface after solving the Poisson problem, and postoptimization processing. For the algorithm of 3D surface reconstruction, the Poisson surface reconstruction algo-

rithm combines the advantages of global and local methods and uses implicit fitting to obtain the implicit equation of the surface information described by the point cloud model its representative by solving the Poisson equation and by performing the equivalence surface extraction on this equation, to obtain the final desired surface model with rich 3D geometric solid information [2].

The model reconstructed by this method has a watertight closure feature with good geometric surface properties and detail properties. The paper carries out related research work to address some defects inherent in the original Poisson reconstruction algorithm. Firstly, for the Poisson reconstruction algorithm of the equivalence surface extraction algorithm, the model hole problem is greatly improved by adding [3] the duality processing and index list expansion method. Animated image 3D reconstruction, as well as facial animation, is two important types of research in the field of computer graphics. Since 3D models have complex spatial structures and rich subtle features, 3D reconstructions of animated images and face animation techniques have

become a major challenge in the field of computer graphics. Nowadays, the research in the field of animation picture recognition can achieve good results to a certain extent, but in practical application, it often encounters various problems such as the angle, pose, makeup, and lighting of the animation picture that have obvious influence on the recognition effect, and the recognition effect is worrying [4]. To avoid the unnecessary influence of these factors on animation image recognition and to improve recognition accuracy, 3D animation image reconstruction also plays an increasingly important role in the research of animation image recognition.

To reconstruct 3D models with detailed character features and achieve more realistic face animation techniques, a lot of research methods have been proposed by academia and industry and applied in cartoon animation production, film and television special effect production, medical visualization, virtual reality (VR), and other fields, while meeting the growing demand for 3D animation image models, making 3D face reconstruction and related animation techniques gradually mature: High-quality face-driven animation techniques for film and television special effects require capturing the facial expressions and semantic information of actors and reproducing this information on virtual character models such as cartoons. Using advanced 3D scanning and facial expression motion capture equipment, realistic facial animation effects can be created in film and game productions [5].

2. Related Work

For the high accuracy solution of the three-dimensional Poisson equation, the literature proposes a multi-grid-based solution, where they combine a compact high-order difference approximation to the multi-grid V-cycle algorithm to solve the two-dimensional Poisson equation Dirichlet boundary conditions. This method, along with several different orders of grid space and projection operations, has shown significant improvements in computational accuracy when compared with the five-point formulation tested on different machines. Solid model reconstruction of directed point sets is a solution to surface reconstruction proposed in the literature. In this paper, it is proposed how to reconstruct a directed point set into a solid, watertight model, and the literature computes the eigenfunction of the solid model by using the Stokes Theorem method. This eigenfunction has a value of 1 inside the model body and 0 outside the model body [6]. An efficient method is also proposed to compute the Fourier coefficients of the eigenfunction, which uses only the sampled surface information and the normal vector to obtain the eigenfunction by computing the inverse Fourier transform and then extracting a solid model using an equivariant surface extraction technique. This approach does not require the establishment of complex proximity relations for the sampled points or the iterative solution of linear equations for large systems and also proposes methods to patch the postreconstruction holes. The Poisson surface reconstruction is proposed in the literature. This reconstruction method does not use heuristic spa-

tial partitioning or blending but takes all points into account at once, thus providing better resilience to data noise. Unlike the radial basis function (RBF, radial basis function) method, the Poisson method allows for a hierarchy that supports local basis functions, so this solution is for the case of sparse linear systems with relatively good support. A multi-scale spatially adaptive algorithm is described on this basis, with time and space complexity are proportional to the size of the reconstructed model.

The Poisson surface reconstruction algorithm is reiterated in the literature and used in practical applications. The literature proposes a parallelized Poisson surface reconstruction. This approach partitions multiple grid domains, and in their implementation, they compare models with multiple processor data sharing and find that parallel execution of distributed storage provides better scalability. Using their approach, a hundred million data point sets can be processed in parallel on 12 processors on three machines for model reconstruction [7], with the data display providing more than nine times the speed up without sacrificing the accuracy of the reconstruction. New scanning and data acquisition techniques allow for a dramatic increase in the size of the dataset for surface reconstruction. The proposed masked Poisson surface reconstruction algorithm in the literature interpolates constraints on the input point cloud data based on the original Poisson surface reconstruction algorithm, and this extension can be interpreted as a generalized representation of the masked Poisson equation in a mathematical sense, where the masked sequence is chosen over a sparse set of points rather than the entire domain in comparison to other image and geometry processing calculations. The paper finds that these sparse constraints can be handled efficiently. Because the modified linear system still retains the same discretization of the finite elements, the sparse structure is unchanged, and the system can still be solved using the multiple mesh approach. Also, they propose algorithms that are effective in reducing the time complexity of solving for the number of linear points and thus now faster [8], higher quality surface reconstruction. The literature presents a framework for surface reconstruction based on scattered point clouds, an algorithm for implicit function surface reconstruction, and the proposed method first builds a series of unoriented surfaces into a hierarchy of surface approximations, represented as a weighted combination of radial basis functions. By treating local hidden blocks as nodes, globally consistent orientations are treated as graph optimization problems. This approach makes it possible to iterate over more points to improve the fitting accuracy and the efficiency of updating the RBF coefficients [9].

In the field of reconstructing 3D face models based on single 2D images, the 3D deformation model 3DMM has been proposed in the literature. As a classical statistical model of 3D faces, 3DMM learns explicitly the underlying prior knowledge of 3D face models in a statistical analysis approach that represents a 3D face model as a linear combination of a set of underlying 3D face models, where this set of underlying 3D face models is obtained by performing the principal component analysis (PCA) on a set of densely

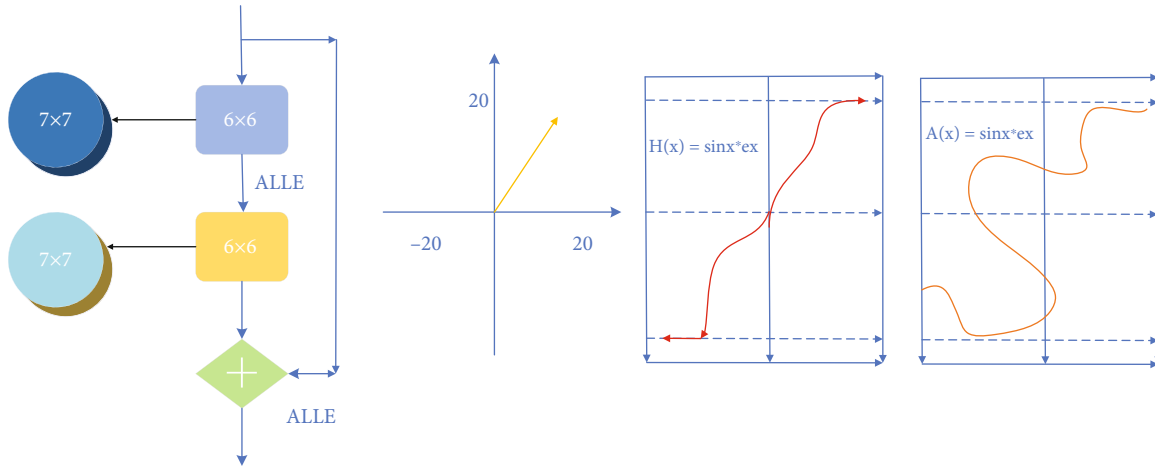


FIGURE 1: The underlying principle of Poisson's equation.

aligned 3D face models. 3DMM treats the 3D reconstruction problem as a kind of 3D model to a 2D image fitting problem. 3DMM-based methods tend to iteratively seek solutions in a parameter space defined by statistical 3D facial and image models. The class of methods starts with an initial set of parameter values and is based on specific changes in the facial feature points of the face iteratively update the parameters, and the final reconstructed 3D face model can be obtained from the optimal parameter values. In contrast to the method that seeks an optimal solution in specific parameter space, another method based on correlation analysis first performs a transformation of the feature space, further exploits the connection between the 3D face model and the 3D reconstruction of the animated image and learns a mapping relationship from the 3D reconstructed facial features of the animated image to the facial features of the 3D face model in the transformed feature space.

3. 3D Reconstruction Method for Animated Images Based on Poisson's Equation

This thesis focuses on introducing a 3D model reconstruction technique based on Poisson's equation for animated images, using a regression-based method that is widely used in 3D model reconstruction to calculate the adjustment amount of 3D face mesh model feature point location information from the change of key point location information of face pictures in 2D space, and further projecting 3D face model feature points onto face images in 2D space. The self-defined feature point dragging tool continuously reduces the error between the 3D reconstructed feature point position information of the animated image and the position information of the 3D face model feature points mapped on the 2D image, to iteratively optimize the reconstructed 3D face model. Among them, the complex mapping relationship between the location information of the key points of the face in the 3D reconstruction of the animated image and the location information of the key points of the corre-

sponding 3D face model is mainly studied, to calculate the 3D spatial location information of the feature points of this 3D face model, i.e., to reconstruct the 3D face model of this user [10]. Poisson's equation is a partial differential equation commonly found in electrostatics, mechanical engineering, and theoretical physics in mathematics. Poisson first obtains the Poisson equation without a gravitational source, $\Delta\Phi = 0$ (that is, Laplace equation); when considering the gravitational field, there is $\Delta\Phi = f$ (f is the mass distribution of the gravitational field). Later, it was extended to an electric field, magnetic field, and thermal field distribution. The equation is usually solved by Green's function method, and it can also be solved by the method of separation of variables and the method of characteristic lines.

3.1. Poisson's Equation. The Poisson equation was developed from the Laplace equation and is therefore closely related to the Laplace equation; they are both a type of partial differential equation. Laplace's equation, also known as the summation equation, or the potential equation, is a type of partial differential equation, named after the French mathematician Laplace, who was the first to study the equation and arrive at the conclusion that it is resolvable in the region where the equation holds, and if any two functions each satisfy Laplace's equation [11], do the summation operation on the two functions, which can be any linear combination, and the result of the summation also satisfies the equation expressed earlier. The basic principle of this equation is represented in Figure 1.

The problem of its solution is a mathematical problem that is frequently encountered in related scientific fields such as electromagnetic, astronomical, and hydrodynamic doctrines. In general, for the three-dimensional case, the problem of Laplace's equation can be reduced to solving a second-order differentiable real function for real independent variables, and this problem is then described in the following form [12]. As the first formula of the article, it can better describe the Poisson algorithm mentioned in the

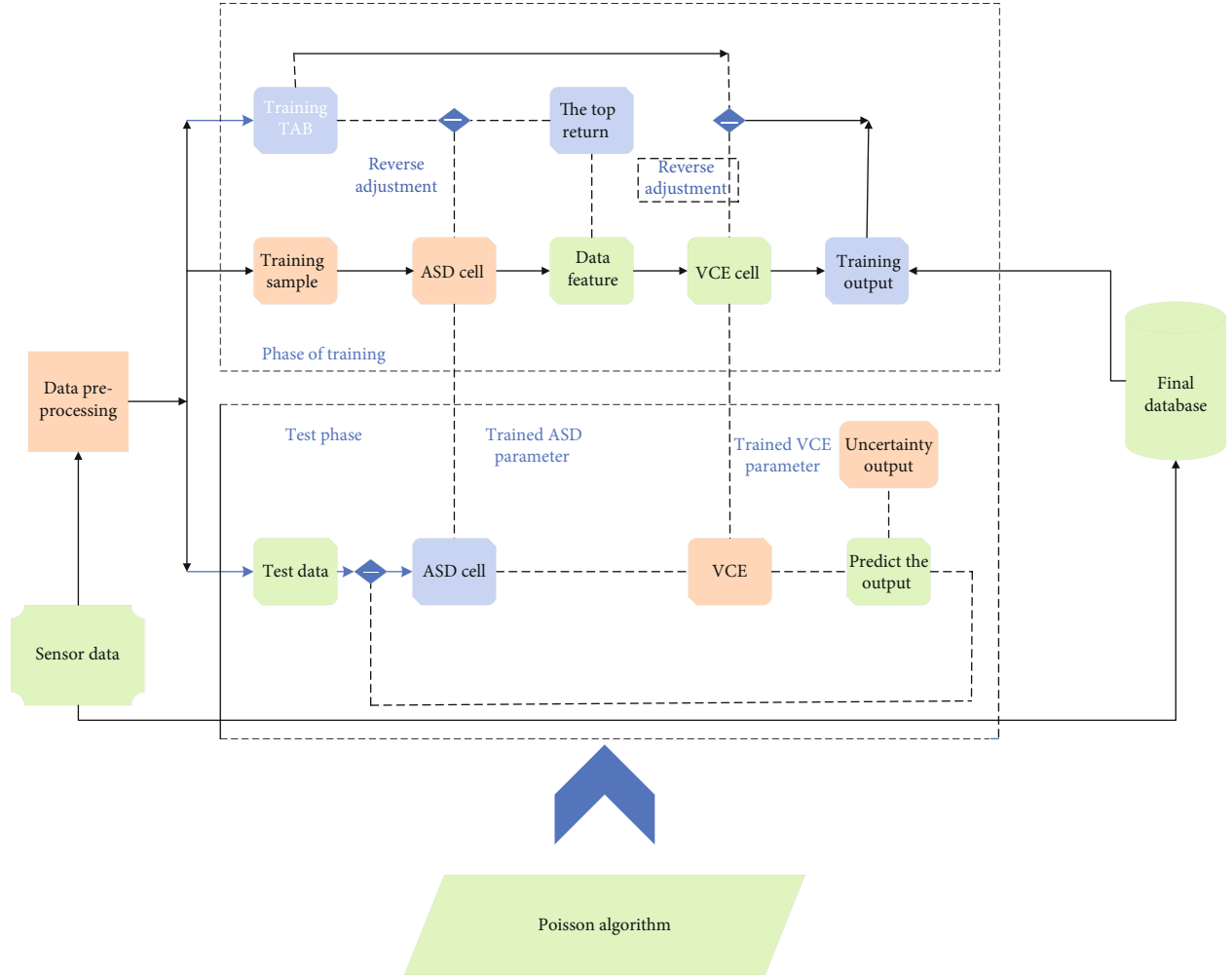


FIGURE 2: Algorithm framework diagram.

article and can better connect the formula mentioned in the article.

$$\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial^2 \varphi}{\partial z^2} = 0. \quad (1)$$

And as the above equation can often be expressed in a simplified way as

$$\text{div grad } \varphi = 0. \quad (2)$$

Based on Poisson's equation, this further extends the concept of 3D reconstruction based on Poisson's algorithm for animated images. Figure 2 shows the framework diagram of Poisson's arithmetic.

3.2. Solution of Poisson's Equation. There are many methods for solving Poisson's equation, which in general can be divided into the following according to the specific implementation: direct solution method, iterative solution method, and multiple grid solution methods [13].

(1) Direct solution method

There are many ways to solve Poisson's problem directly; typical solution methods are decomposition methods. The reason for matrix decomposition is that when the amount of data is very large, decomposing a matrix into the product of several matrices can make a large saving in storage space but also can significantly reduce the amount of computation when processing the real problem because for an algorithm to deal with fewer elements, its completion time is correspondingly faster. This is because the fewer elements an algorithm has to deal with, the faster it will take to complete the operation [14]. The principle of the formula is

$$A = \frac{1}{n} \sum_{i=1}^n X_i Y_i + \frac{x - \mu}{\sigma}. \quad (3)$$

(2) Multiple grid solution methods

Many scholars have extensively and profoundly researched the multigrid algorithm, explained the meaning

and basic principles of multigrid, applied the multigrid algorithm to many fields, and finally obtained the optimal efficiency of numerical operations. The convergence problem has also been well solved, and it is active in many numerical computation fields today. Multiple grids are widely used in solving Poisson's equation because of their relatively fast solution speed, especially in solving Poisson's equation arising from graphical image problems, which is unsurpassed by other methods. For the two-dimensional Poisson equation:

$$A = \sum_{i=1}^n X_i \cdot \left(\frac{x - \mu}{\sigma} \right). \quad (4)$$

Iteratively solving the set of equations consisting of partial differential equations after discretization because for a certain grid, it is relatively easy to remove the error components corresponding to the wavelength and the step length of the grid, so the multiple grids solving Poisson's equation problem are a fast computational method, which mainly uses grid cells with different scale sizes, for different sparsity of the grid cells to remove the error components of different wavelengths, respectively. It solves the problem of rough grid correction, mainly the error correction subproblem on the rough grid and the fine grid difference error correction method. A large amount of time is guaranteed to do the main operational work of the rough grid. One of the simple multiple-grid V-cycle iterations also uses other techniques for error smoothings, such as the Gauss-Seidel method or the Jacobi method. To obtain an approximation of the smoothed error equation for the rough grid, this interpolation needs to be added to the error correction for the rough grid by first interpolating the error correction for the fine grid [15].

(3) Poisson's equation for shielding

The shielded Poisson equation remains a type of partial differential equation, which takes the form of something like.

$$B = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}. \quad (5)$$

In order not to lose the generality of the equation, the algorithm takes the value of A to be nonnegative, and the shielded Poisson equation degenerates to the Poisson equation when the value of A is zero; that is, when $A = 0$

$$B = \arccos \theta e^{-(x-\mu)/\sigma}. \quad (6)$$

Thus, in the three-dimensional case, when the value of A is small, the shielded Poisson equation represents the weighted superposition of functions homologous to the function.

$$B = \frac{1}{n} \sum_{i=1}^n X_i Y_i - \sum_{i=1}^n X_i. \quad (7)$$

3.3. *Equivalence Surface Extraction for Animated Images.* The equivalent surface visualization method is a surface reconstruction method to extract the equivalent curvature from scattered points in the process of drawing human body structure image in 3D spatial data field. It is also widely used in the method of surface reconstruction for extracting a value equivalent surface from scattered points and the method of extracting intermediate frames from keyframe animation. There are many methods and techniques of contour surface extraction, and the following methods are briefly summarized for contour surface extraction in 3D spatial data fields [16].

(1) Contour-based equivalence surface extraction method

Contour tracing is an early contour surface extraction algorithm that extracts sequences of exclusive contour lines of interest to the user based on specified requirements and then reconstructs the contour surface based on these sequences, by using triangular surface slices to trace contour lines belonging to the same object mapped to its neighboring slices, by extracting each [17] two-dimensional information slice of contour lines and thus obtain the equivalence surface represented by the region of interest. The principle of the formulation is

$$B = \sum_{i=1}^n X_i^2 + \frac{x - \mu}{\sigma}. \quad (8)$$

The problem faced by this method is that for adjacent slices that may have complex structural situations perhaps causing an unavoidable large number of splicing errors, this is due to the polysemy of correspondence of contour lines on adjacent slices, and also for the same slice, there may be multiple different closed contour lines, so the method of connecting contour lines on adjacent slices faces many difficulties. The procedure of the slice contour-based surface reconstruction algorithm is shown in Figure 3.

(2) Voxel-based isosurface extraction method

The earliest voxel-based method for equivalence surface extraction is the cubic block method (Cuberille), which binarizes the volume data by equivalence values, connecting all externally facing boundary faces for each voxel (i.e., cubic block) that is on the boundary, using the six faces of the boundary cube to fit the equivalence surface, removing only the faces of the boundary cube that duplicate each other [18], and by connecting faces that do not overlap with each other. Even if the speed of rendering is not a concern, a reconstructed rendering can be achieved directly by displaying the boundary voxels nontransparently, without removing the inner faces of the cube. The principle of the formula is

$$N = \frac{1}{n} \sum_{i=1}^n X_i^2 + \frac{1}{n} \sum_{i=1}^n X_i Y_i. \quad (9)$$

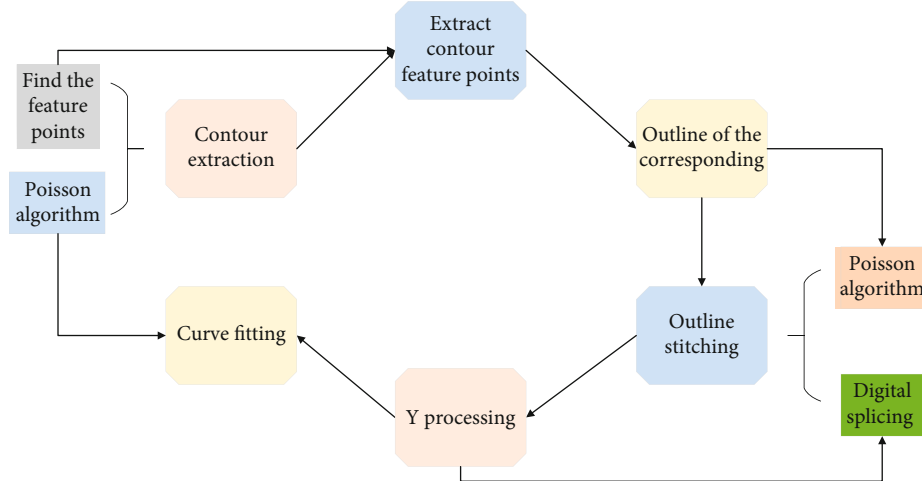


FIGURE 3: Slice contour-based reconstruction.

TABLE 1: Comparison of voxel-based equivalence surface extraction algorithms.

Different methods	Traditional method	Poisson equation algorithm
Calculation amount	Big	Small
Methodological	Can	Can
Geometric difficulty operation	Difficult	Simple

The algorithm is characterized by the fact that there is no interpolation between voxels, so it is very simple to implement and facilitates parallel processing due to the high degree of independence between the data. But the problem faced by the method is that the final obtained equivalence surface is a block-shaped surface composed of small planes of adjacent voxels perpendicular to each other, which will have a large walk for the surface information representation [19], not smooth and not reflect the detailed information of the object well. Table 1 shows the comparison of voxel-based equivalence surface extraction algorithms.

3.4. 3D Animation Image Reconstruction Technology Basis.

The reconstruction process involves a variety of spatial coordinate systems, including object coordinate system, world coordinate system, camera coordinate system, and screen coordinate system, where the object coordinate system is the local coordinate system of the object, which is the initial position before applying any coordinate transformation, and the object coordinates can be mapped to the camera coordinate system by translation, rotation, and scaling, and to the screen coordinate system by perspective projection or orthogonal projection. The specific complex spatial transformation relationship is a necessary step for 3D model coordinate transformation, and a clear transformation idea often makes the development much more efficient. As opposed to a fixed parametric 3D face model, this paper uses a 3D regression algorithm [20], which learns an input-to-output mapping relationship using the 3D reconstruction of an ani-

mated image as input and the spatial location information of the 3D face model feature points as output. This method is significantly better than the above methods in reconstructing the detailed features of model expressions. Considering the degree of effective understanding of face feature points to 3D face model features, therefore using face feature points to reconstruct the 3D model can effectively reconstruct the detail features of the facial model; the method can design a regression function to achieve the mapping between 2D face feature points and the adjustment amount of the 3D face model. The principle of its formula is

$$N = \left(\frac{x - \mu}{\sigma} \right) \cdot \frac{dy}{dx}. \quad (10)$$

In a conventional 1D linear sensor, data from one column (row) of sensor cells is used to reconstruct a 2D image, and different scans can be achieved by selecting different apertures and turning different sensor cells on or off. Similarly, two-dimensional planar sensors are capable of volumetric scanning.

For two-dimensional ultrasound transducers, the transducer material often has a large impact on the overall sampling frequency and reconstruction frame rate. Although 2D ultrasound transducers are capable of dynamically reconstructing 3D images in real-time, the impedance of each transducer cell is much larger than that of a 1D line array, which makes impedance matching for 2D surface array transducers particularly difficult. In addition, to avoid mutual interference between sensor cells, each sensor cell needs to be at least half a wavelength away from each other [21], which in turn makes the size of the sensor cells limited. The principle of the equation is

$$M = \frac{\partial^2 \Omega}{\partial v^2} \cdot \frac{dy}{dx}. \quad (11)$$

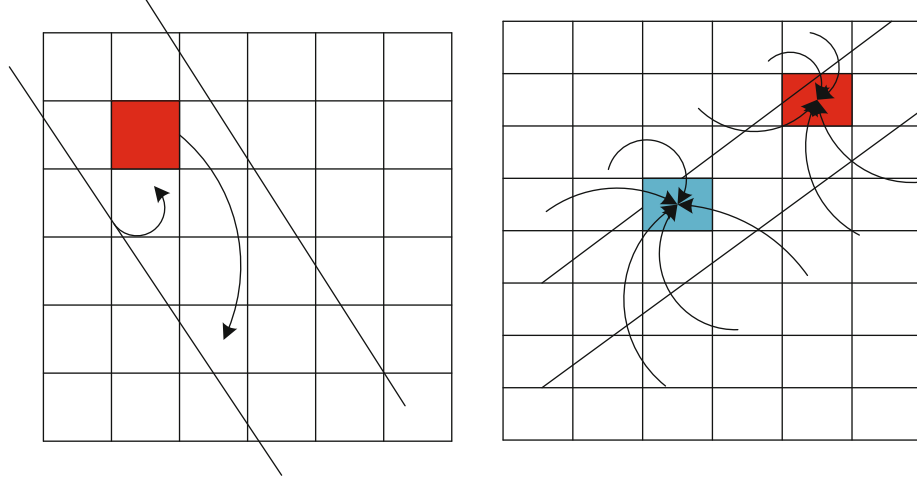


FIGURE 4: Fundamentals of 3D animated image reconstruction techniques.

The flexibility and portability of handheld sensors allow clinicians to scan areas of ROI (region of interest) in specific orientations and positions, allowing the clinician to select the best view and scan plane. The primary issues to be addressed in 3D imaging are positioning and orientation. There are four main common localization methods, involving acoustic localization, optical localization, articulated arm localization, and magnetic localization. In addition to these, there are reconstruction algorithms that are based solely on images and are independent of the sensor position. After being able to acquire 3D data accurately and quickly, the speed and accuracy of 3D body reconstruction directly affect the speed and accuracy of the overall 3D reconstruction. Many reconstruction methods have been able to scan and image in real-time, and most of these methods are based on traditional 3D reconstruction algorithms and parallel computing. Specifically, real-time 3D voxel-based reconstruction algorithms can be divided into three categories: voxel-based method (VBM), pixel-based method (PBM), and function-based method (FBM). All these methods are based on the interpolation of 2D images reconstructed from 1D line array sensors combined with sensor localization into 3D regions; thus, the algorithms discussed here are the process of interpolating 2D images into 3D. Figure 4 represents the basis of the 3D animated image reconstruction technique.

Structure from motion (SFM) reconstruction is a method to recover the external parameters of the camera and the external scene structure under the condition that the internal parameters of the camera are known. The incremental reconstruction method is a widely used reconstruction method, which restores the scene structure by adding new images step by step. The incremental reconstruction shows scene drift in large reconstructed scenes due to the accumulation of positional errors. The principle of its formula is

$$T = \frac{\partial^2 \Omega}{\partial v^2} \cdot \frac{\partial^2 \Omega}{\partial u \partial v}. \quad (12)$$

Also, the method increases the number of parameters to be estimated as the number of images increases, resulting in slower reconstruction. To speed up the reconstruction, the reconstruction process is accelerated by using parallel computing hardware such as GPU and FPGA. The advantage of the global reconstruction method is that it does not drift, but the method requires high feature matching accuracy to improve the quality of feature points, which leads to a decrease in reconstruction integrity. Compared to incremental reconstruction, the number of global reconstruction iterations is reduced, and there is no cumulative error, but it is sensitive to external points, and the reconstruction accuracy is not as high as incremental reconstruction. The hybrid reconstruction method estimates the rotation matrix by taking the global reconstruction, and the incremental method estimates the camera displacement. The reconstruction is accelerated while avoiding scene structure drift.

4. Experimental Results and Analysis

For 3D reconstruction of ordered images, the initial point cloud is first calculated according to the order of image acquisition, and then, the newly obtained images are added to the point cloud, and the order of addition is now followed by the time of image capture. However, in large scenes, the reconstructed image set is likely to have images without common feature points; when encountering the situation that there is no feature point matching with the current newly added image in the reconstructed point cloud, the 3D reconstruction according to the reconstruction process of ordered images will fail to be reconstructed. The principle of its formula is

$$T = \frac{\Delta y}{\Delta x} \cdot \frac{dy}{dx}. \quad (13)$$

If the reconstructed scene is the image taken by the car during driving, i.e., the image sequence is guaranteed to correspond to the scene sequence, then the scene can be

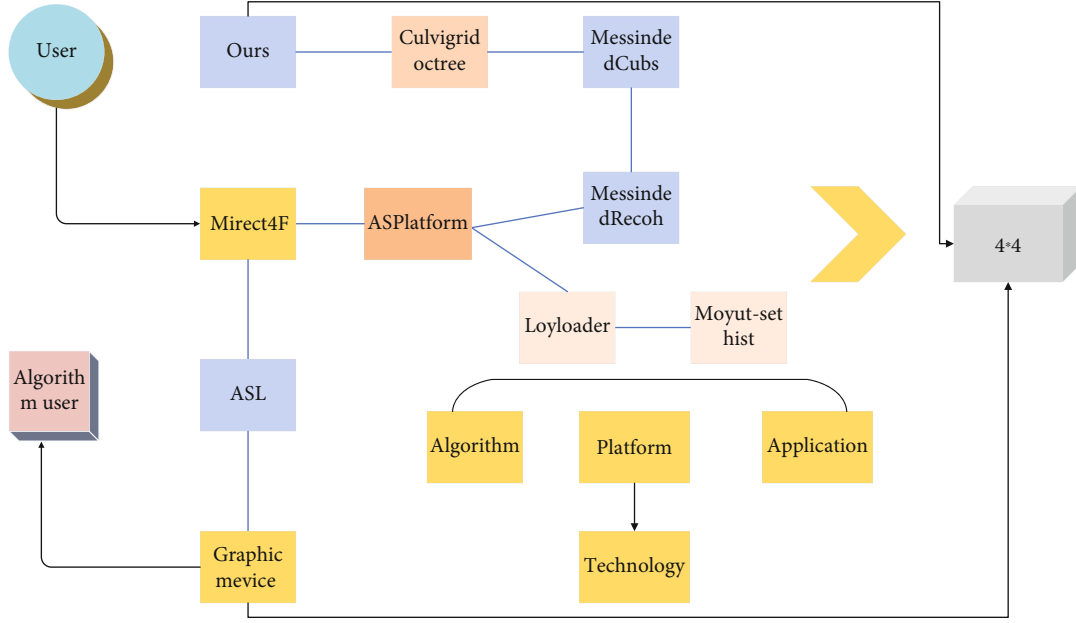


FIGURE 5: Experimental platform structure.

reconstructed by using 3D reconstruction of ordered images. However, such a reconstruction is unstable, and to design a more robust reconstruction procedure, the reconstruction of unordered 3D images needs to be considered, and the experiments conducted in this paper are based on this, with the experimental platform based in Figure 5 shown in.

The Poisson equation-based 3D surface reconstruction technology is based on the existing sparse or dense 3D point cloud model obtained through image sequences or other methods of 3D point cloud reconstruction. Here, we adopt the method of three-dimensional spatial partitioning of the octree, placing each part on the subnodes of different depths of the octree, conducting the process of Poisson's equation for the whole surface represented by the point cloud, and then carrying out the surface reconstruction process of equivalent surface extraction to finally obtain a 3D spatial surface solid model with 3D surface information and a rich degree of detail presentation. The principle of the equation is

$$h = \frac{\partial^2 \Omega}{\partial u^2} \cdot \frac{\partial^2 \Omega}{\partial u \partial v} \cdot \frac{dy}{dx}. \quad (14)$$

To sufficiently verify the feasibility of the algorithm described in the thesis, to prevent the interference of unnecessary factors, to avoid the existence of errors caused by too many discrete point data due to errors in the process of collecting point cloud models, and to avoid the problems caused by wrong point cloud information or too little information in the point cloud data, the experimental data are collected here mainly through the existing mature and ready-made 3D point cloud models. The main objective is to obtain the experimental data by using the established 3D point cloud model, supplemented by a simple point cloud model with a small number of points. The principle

of the formula is

$$R = \frac{\delta y}{\delta x} \cdot \frac{dy}{dx} \cdot \frac{\Delta y}{\Delta x}. \quad (15)$$

4.1. Experimental Results. In the specific experiments, different parameters are set for several models, and the original Poisson's equation-based surface reconstruction algorithm is compared with the optimized shielded Poisson's equation-based surface reconstruction algorithm. After the optimization of the algorithm, the overall model detail reduction is more perfect, and the model hole problem generated in the reconstruction process is significantly reduced. The experimental results of the data are shown in Figure 6.

It can be concluded that the overall algorithm has been optimized to obtain a greater improvement than the original algorithm. Similarly, after practical experiments, it is proved that the improved Poisson reconstruction algorithm based on the shielded Poisson equation, by using interpolation constraints on the input information for preprocessing, postprocessing after the optimization of the equivalence surface extraction algorithm, differs from the original Poisson reconstruction algorithm based on the Poisson equation. The postprocessing, after optimization of the equivalence surface extraction algorithm, is significantly different from the original Poisson equation-based Poisson reconstruction algorithm.

4.2. Analysis of Experimental Results. After several functional tests, although this system was able to achieve the nominal functions, some existing problems were found at the same time during the use. The graph of its final experimental results is shown in Figure 7.

In the viewer interface, if the user performs a batch add operation, occasionally the program does not respond and

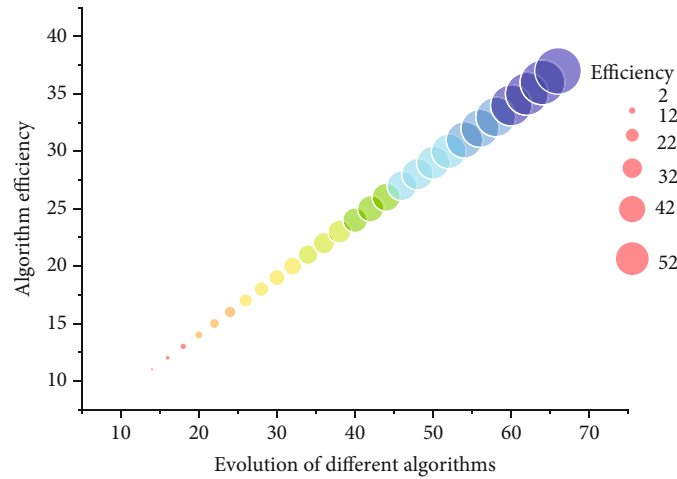


FIGURE 6: Comparison of the efficiency of the 3D reconstruction of Poisson’s equation.

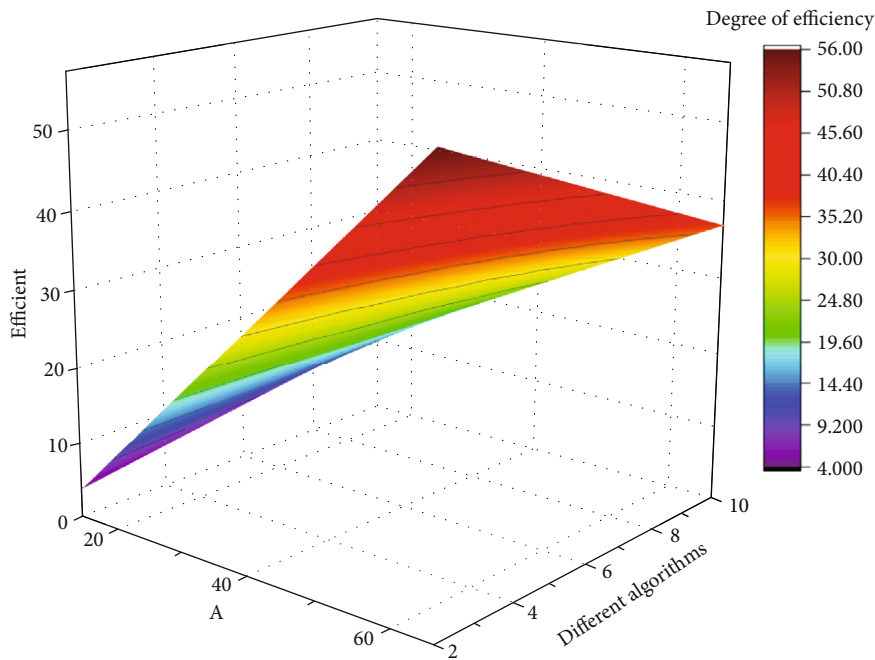


FIGURE 7: Efficiency analysis chart.

the system loads slowly. In the face feature detection module, it takes some time to load because some libraries in Python are called, but the user may think that the function button is not clicked and thus repeat the operation. To prevent similar misuse, a progress bar is added to check the current running status of the system. Second, personalization needs to be improved. This system uses 2D images of faces under unconstrained conditions as input and outputs 3D models of faces. And the reconstruction technology is extended to practical applications so that more people have more practical experience in areas such as stereo vision and human-computer interaction. Although the existing face 3D reconstruction system has functions such as browsing and feature point viewing of loaded images, it does not provide further explanation and demonstration in the actual

3D reconstruction process, and the detailed introduction of this system enables users to have a deeper knowledge and understanding of the face 3D reconstruction process.

The current version of the system must continue to enhance the personalization design because there are not many software systems that perform 3D reconstruction of faces through unconstrained images and visualize them, and by further exploration and enhancement, the face 3D reconstruction technology can be brought into the lives of more ordinary people. With rich categories of 3D reconstruction and more processes, each step deserves more in-depth exploration to better extend and improve related functions and enhance user satisfaction. Through the above analysis, this algorithm currently has many aspects to be improved, and it is worth encouraging to achieve the input

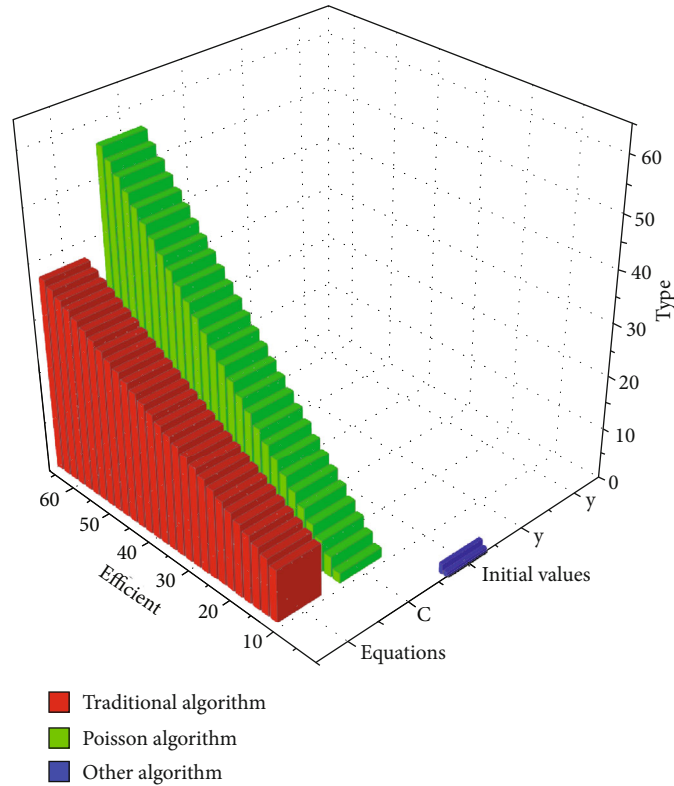


FIGURE 8: Modeling efficiency diagram.

of face images under unconstrained conditions and reconstruct the corresponding 3D model of the face quickly and accurately, with the efficiency shown in Figure 8.

With the increasing demand for face 3D models, there is bound to be huge room for the development of applications similar to this system, which will become an indispensable part of people's life and entertainment in the future. In the future improvement, this system will add more new methods with excellent performance in time to meet the user's increasingly strong personalized demand for face 3D reconstruction and make more intelligent and humanized application products in this technology field.

5. Conclusion

With the rapid development of computer vision technology, people's research on many aspects of animation images has gradually matured. For example, face recognition, from the previous traditional image processing methods based on SIFT features, to today's deep learning methods, there has been a whole set of research systems for the 3D reconstruction of animated images. However, images limited to the two-dimensional plane are increasingly unable to deal with many of the problems encountered today. Therefore, many research scholars have turned their research direction to 3D models of faces. However, the primary problem is that access to models is very difficult, and the number of models is low, which sets a big obstacle in the research process. Moreover, the process of 3D reconstruction often implies a huge amount of computation, which is a serious challenge

for both the reconstruction algorithm and the hardware implementation. To overcome the current problems that exist, an effective and convenient 3D reconstruction method for faces is urgently needed. In this paper, after studying existing methods and combining computer graphics and deep learning contents, we propose a 3D reconstruction method for faces based on deformation model, which transforms the traditional parameter solving the problem of deformation model into an image learning problem and design and produce a simple and effective animation image reconstruction system.

Since previous 3D reconstruction methods have certain shortcomings, the main content of this paper is the 3D reconstruction of a human face with a deformation model as the research object. Firstly, the deformation model is introduced, and the generalization ability is partially improved by the two classical deformation model datasets that are combined. This is followed by feature point detection on the sample images using cascade regression. The original 2D image and the corresponding 3D data information are transformed into UV space based on the inheritance of previous scholars' work to obtain the position map under UV space. By designing a network structure containing two main parts of convolution and deconvolution and selecting appropriate loss functions, a new location map is generated, and a very realistic 3D model of the face is finally generated by meshing and thus achieving a 3D reconstruction of the face with texture mapping. It is demonstrated by several sets of comparative experiments that the proposed method is very realistic for the shape-shifting model of the human face.

The effectiveness of the face 3D reconstruction method in terms of face alignment, face alignment in large angle cases, face 3D model reconstruction, and computational consumption, its shown through experimental results that the Poisson equation based 3D reconstruction method for animated images, is efficient and effective. At the end of the article, Poisson's equation can play a certain role in an image restoration algorithm in the future. A new image restoration algorithm based on gradients can remove influential objects from pictures or photos. This is the Poisson equation.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that no known competing financial interests or personal relationships could have appeared to influence the work reported in this paper.

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