

# The study of art design method based on 3D virtual vision

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**Abstract.** Because it cannot obtain enough information, the traditional virtual 3D image simulation method in art design direction, can only be based on the simple, upward, rotation rough information to complete simulation of three-dimensional images of the art design, the effect is not good. This paper presents a new three-dimensional image simulation method for multimedia virtual art design. a set of samples in art's three-dimensional space is looked for, and the use of approximate estimation probability density function, reduce the estimation error of art design direction, and instead the integral operation with sample mean, or state minimum variance distribution, to estimate the direction and angle of the incomplete 3D image in art. Through the angle information make multiple targets fusion for 3D image of art design. Experimental results show that using the algorithm for virtual 3D image simulation of art design can reflect the real process of art design, so as to provide accurate decision making basis for art design.

## Introduction

As the level of art design technology continuously improving, it puts forward some innovative to all kinds of design method [1]. If the art design appears such incomplete problems in the accident, it needs for timely restoration of art, thus realizing the optimization design of art [2]. In the process of art design, it should be according to the 3D image characteristics of art, to predict the direction and angle of 3D image, ensuring the integrity of art design [3-6].

Three dimensional simulation method of design art, is the core problem needed to research in the process of processive design of art. Using the traditional algorithm for simulation analysis 3D images in art design, it need according to the 3D image feature of art to predict the direction and angle of 3D image of art design. Because the residual information of 3D image of art is too small, resulting in that using the traditional virtual 3D image simulation method in art design cannot get enough information, and only be based on the simple, upward, rotation rough information to complete simulation of three-dimensional images of the art design, the effect is not good[7-10].

## Virtual 3D image simulation principle of art design

In some special cases, art is prone to incomplete, which needs for timely 3D virtual design. 3D virtual design process of Art needs according to incomplete image's characteristics to predict image's direction and angle, to ensure complete recovery of art. The relevant principles are as follows:

Connecting the edge points of the 3D image in 3D art designing, obtain the results and it can be described by  $U = (Z_1, A_1, B_1, \dots, Z_q, A_q, B_q)^T \in T^{3q}$ . where,  $q$  can be used to describe the quantity of all the edge points. the direction vector of each edge points of 3D image in art is described by  $U_k$ , and  $k = 1, 2, \dots, p$ . The direction vector are normalized, to get a new direction vector  $U$  of art's three-dimensional image, according to the value of the vector, it can obtain the linear combination result of art's 3D image edge point vector, the formula is as follows:

$$U = \sum_{k=1}^p y_k U_k \quad (1)$$

Ascending order is made for incomplete features of 3D images of art, and the projection matrix is calculated, to get the following results:

$$U = \bar{U} + Rv \quad (2)$$

In the formula,  $\bar{U}$  is used to describe the gray mean value of art's incomplete three-dimensional image,  $v$  can be used to describe the projection matrix of art's incomplete three-dimensional image feature. Supposing that the morphology of art's incomplete three-dimensional image changes, it can get the following multi pose model of art's incomplete three-dimensional image:

$$U^T = \bar{U}^T + R^T v \quad (3)$$

Among them,  $T$  is angle deflection matrix of art's incomplete three-dimensional image,  $U^T$ ,  $\bar{U}^T$  and  $R^T$  are used to describe the parameter of angular deflection state of art's incomplete three-dimensional image.

All image feature points are marked on the image's angle deflection vector, to form a set can be expressed by  $\{U^m\}$ . According to the data get the sparse model of 3D image model of incomplete art, and then the attitude transformation processing is made, so as to obtain the following results:

$$(U^m)^T = (\bar{U}^m)^T + (R^m)^T v \quad (4)$$

By using projection matrix, the incomplete art's 3D image feature can be projected to art design and the 3D image plane figure, so as to obtain the following formula:

$$(U^m)^{NT} = (\bar{U}^m)^{NT} + (R^m)^{NT} v \quad (5)$$

$[(U^m)^{NT} - (\bar{U}^m)^{NT}]$  is processed using the projection method, can obtain the three art's incomplete dimensional image feature space  $[(R^m)^{NT}]$  corresponding to obtain the model reconstruction coefficient of art's incomplete three-dimensional images, as follows:

$$v = [(R^m)^{NT}]^+ [(U^m)^{NT} - (\bar{U}^m)^{NT}] \quad (6)$$

Among them,  $(U^m)^{NT}$  can be used to describe the feature points of art's incomplete 3D images,  $[(R^2)^{NT}]^+ = [(R^2)^{NT}]^T (R^2)^{NT})^{-1}$  is the corresponding transform matrix. According to the coefficient reconstruction, the virtual 3D image model of art design can be re-created.

## Simulation optimization process analysis of virtual 3D image in art design

**Estimation method for the direction and angle of art's incomplete three-dimensional image.** In this paper, by using the particle filtering method estimate the direction and the angle of art's 3D image, the detailed steps are as follows:

(1) Initialization processing of particle swarm. A set of feature points of art's three-dimensional image are randomly chosen, this group of feature point are set as the initial particle, and be made impulse function operation, so as to obtain the corresponding particle value  $\{i_0^j, j=1,2,\dots,P_q\}$ , the corresponding weights can be expressed by  $\frac{1}{P_q}$ .

(2) using the following formula update particle:

$$i_p = \beta i_{p-1} + (1-\beta)w_p \quad (7)$$

(3) using the following formula calculate the similarity of direction vector of art's 3D image feature point:

$$lik_p^j = q(Z_p | i_p^j) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{|Z_p - \hat{r}_p i_p^j|^2}{2\sigma^2}} \quad (8)$$

(4) using the following formula make normalization for weights of art's 3D image feature point:

$$x_p^j = \frac{lik_p^j}{\sum_{j=1}^{P_q} lik_p^j} \quad (9)$$

(5) using the following formula effectively estimate the direction of art's 3D image:

$$\begin{aligned} p(i_p^j | Z_{1:p}) &\approx \sum_{j=1}^{P_q} x_p^j (i_0 : p - i_{0:p}^j) \\ &= \frac{1}{P_q} \sum_{j=1}^{P_q} \varepsilon(i_{0:p} - i_{0:p}^j) \end{aligned} \quad (10)$$

(6) using the following formula effectively estimate the angle of art's 3D image:

$$\begin{aligned}\hat{i}_p &= F(i_p) = \int i_p p(i_p | Z_{1:p}) dI_p \\ &\approx \frac{1}{P} \sum_{j=1}^{P_i} i_p^j\end{aligned}\quad (11)$$

**The establishment of three-dimensional image model of art.** Using  $E_1$  and  $E_2$  collect the three-dimensional image in art design, which, the acquired feature point of  $E_1$  is described by  $r_1$ ,  $E_2$  is described by  $r_2$ , the corresponding points in real art of the two feature points can be depicted by  $R$ . In the Cartesian coordinate system, the space position of the target feature points can describe the edge position of art's 3D image.

Assuming that the projection matrix of feature point  $r_1$  and  $r_2$  can use  $P_1$  and  $P_2$  to describe, it can get the following results:

$$\begin{aligned}B_{e1} \begin{bmatrix} w_1 \\ x_1 \\ 1 \end{bmatrix} &= \begin{bmatrix} p_{11}^1 & p_{12}^1 & p_{13}^1 & p_{14}^1 \\ p_{21}^1 & p_{22}^1 & p_{23}^1 & p_{24}^1 \\ p_{31}^1 & p_{32}^1 & p_{33}^1 & p_{34}^1 \end{bmatrix} \begin{bmatrix} Z \\ A \\ B \\ 1 \end{bmatrix} \\ B_{e2} \begin{bmatrix} w_2 \\ x_2 \\ 1 \end{bmatrix} &= \begin{bmatrix} p_{11}^2 & p_{12}^2 & p_{13}^2 & p_{14}^2 \\ p_{21}^2 & p_{22}^2 & p_{23}^2 & p_{24}^2 \\ p_{31}^2 & p_{32}^2 & p_{33}^2 & p_{34}^2 \end{bmatrix} \begin{bmatrix} Z \\ A \\ B \\ 1 \end{bmatrix}\end{aligned}\quad (12)$$

Among them,  $(w_1, x_1, 1)$  and  $(w_2, x_2, 1)$  are the spatial coordinates of different feature points,  $p_{kl}^m (m=1, 2; k=1, 2, 3; l=1, 2, \dots, 4)$  is the  $l$ -th element of  $P_m$  in row  $k$ . The projection matrix is made expansion treatment, can get the following results:

$$\begin{aligned}B_{e1} w_1 &= p_{11}^1 Z + p_{12}^1 A + p_{13}^1 B + p_{14}^1 \\ B_{e1} x_1 &= p_{21}^1 Z + p_{22}^1 A + p_{23}^1 B + p_{24}^1 \\ B_{e1} &= p_{31}^1 Z + p_{32}^1 A + p_{33}^1 B + p_{34}^1\end{aligned}\quad (13)$$

The above formula is made transform processing, can remove the  $B_{e2}$ , to get the model of the 3D image in art design as follows:

$$\begin{aligned}(w_2 p_{31}^2 - p_{11}^2) Z + (w_2 p_{32}^2 - p_{12}^2) A + (w_2 p_{33}^2 - p_{13}^2) B &= p_{14}^2 - w_2 p_{34}^2 \\ (x_2 p_{31}^2 - p_{21}^2) Z + (x_2 p_{32}^2 - p_{22}^2) A + (x_2 p_{33}^2 - p_{23}^2) B &= p_{24}^2 - x_2 p_{34}^2\end{aligned}\quad (14)$$

## Experiment results and analysis

In order to verify the method of three-dimensional image simulation based on multimedia virtual art design proposed in this paper, it needs for an experiment. In the process of the experiment, C++ programming language is used.

From a large number of 3D images in art design, a frame image is randomly selected as target. Aiming at the target make feature extraction, obtaining the results can be used to describe as below:

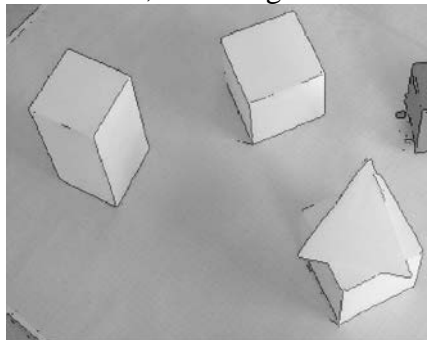


Figure 1 Three dimensional sample images in art design

In the incomplete 3D image samples in artwork design, the space position of the extracted feature point's distribution can be described by the following table:

Table 1 sample feature point distribution of incomplete3D image in art design

NO.	coordinate	NO.	coordinate
1	(23,48)	11	(67,66)
2	(84,24)	12	(57,37)
3	(44,64)	13	(27,27)
4	(49,16)	14	(64,27)
5	(74,29)	15	(27,57)
6	(59,94)	16	(33,29)
7	(57,19)	17	(64,27)
8	(98,81)	18	(64,28)
9	(22,37)	19	(37,29)
10	(37,28)	20	(56,66)

The use of the traditional algorithm and the algorithm respectively make the experiment, and the experimental results can be used to describe as below:

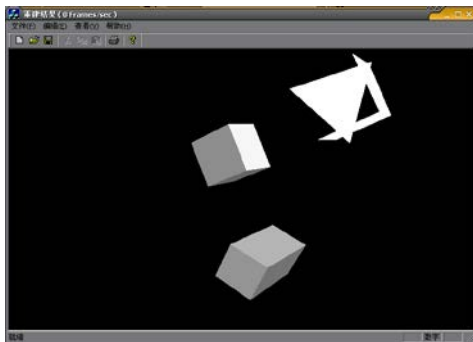


Figure 2 The simulation results in the traditional algorithm

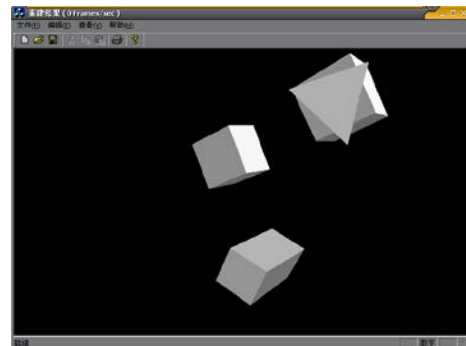


Fig. 3 the simulation results of the proposed algorithm

The error of direction and angle analysis estimation of 3D image of art design the in the process of experimental simulation is analyzed to obtain the following results:

Table 2 experimental data of using different algorithm for 3D image direction estimation of art evaluated error of the direction of Art work

The number of experiments	of three-dimensional image (%)	
	Traditional algorithm	The proposed algorithm
1	14	6
2	15	8
3	14	6
4	14	7
5	13	5
6	15	6
7	14	8
8	16	6
9	17	7
10	13	6

Table 3 experimental data of using different algorithm for 3D image angle estimation of art

The number of experiments	evaluated error of the direction of Art work three-dimensional image (%)	
	Traditional algorithm	The proposed algorithm
1	22	8
2	24	9
3	22	8
4	26	8
5	24	6
6	25	9
7	24	6
8	23	9
9	24	7
10	21	6

Based on the data in the above table, it can be learned that using the proposed algorithm for the 3D simulation analysis, and the art direction and angle estimation of art design, the estimation error is far less than that of the traditional algorithm, fully demonstrating the advantages of the proposed algorithm.

## Conclusions

This paper presents a method of three-dimensional image simulation based multimedia virtual art design. Using particle filter estimation algorithm, estimate the direction and the angle of 3D image of art, and provide the basis for 3D image simulation of the multimedia virtual art design. The use of multimedia virtual technology, the effective simulation analysis of three-dimensional image of art is performed. Experimental results show that using the algorithm for virtual 3D image simulation of art design can truly reflect the relevance between different 3D image features in the art design, and reflect the direction and the angle of a three-dimensional image of art design, thus providing data basis for art.

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