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A Study of Utilizing 2D Photo Scan Technology to Efficiently Design 3D Models

Dawei Guo*, Jeanhun Chung**

Dept. of Multimedia, Graduate School of Digital Image &Contents, Dongguk University, Doctor's Course*

Dept. of Multimedia, Graduate School of Digital Image &Contents, Dongguk University, Professor**

2D 포토 스캔 기술을 활용한 효율적인 3D 모델링 제작방법 연구

곽대위*, 정진헌**

동국대학교 영상대학원 멀티미디어학과 박사과정*, 동국대학교 영상대학원 멀티미디어학과 교수**

Abstract Generally, in special effect video and 3D animation design process, character and background's 3D model is built by 3D program like MAYA or 3DS MAX. But in that manual modeling mode, model design needs much time and costs much money. In this paper, two experimental groups are set to prove use 2D photo scan modeling mode to build 3D model is effective and advanced. The first experimental group is modeling the same object by different experimental setting. The second experimental group is modeling the same background by different experimental setting. Through those two experimental groups, we try to find an effective design method and matters need attention when we use photo scan design mode. We aim to get the model from whole experiment and prove photo scan modeling mode is effective and advanced.

Key Words : Photo scan, 2D, 3D, Point cloud, Modeling

요 약 일반적으로 특수영상 및 3D 애니메이션 제작에서 캐릭터와 배경을 3D 모델링을 할 때 MAYA나 3DS MAX 등의 3D 프로그램을 사용하여 제작한다. 그러나 이러한 제작방식은 작업 시간이 많이 소요될 뿐만 아니라 고비용이 발생한다. 본 연구에서는 2D 포토스캔 제작기술을 활용한 3D 모델링 제작방법의 우수성과 효율성을 증명하기 위하여 두 가지 실험을 하였다. 첫 번째, 동일한 오브젝트를 다양한 방법으로 모델링을 하였다. 두 번째, 동일한 백그라운드를 각기 다른 방법을 이용하여 모델링을 하였다. 이 두 가지 실험을 통하여 효과적인 2D 포토스캔 제작방법으로 모델링 시 유의해야할 사항과 제작기술 등을 제시하였다. 또한 실험에 따른 결과물을 바탕으로 2D 포토스캔 모델링 제작방법의 효율성과 우수성을 증명하였다.

주제어 : 포토 스캔, 2D, 3D, 점군 데이터, 모델링

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Corresponding Author: Jeanhun Chung(Dongguk University)
Email: evengates@gmail.com

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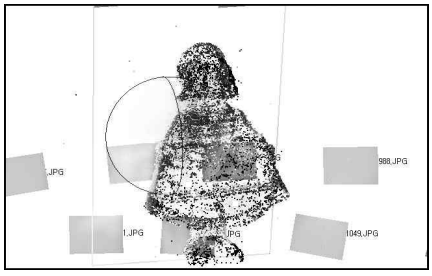
1. Research Background and Photoscan Principle

In traditional 3D modeling process, 3D design programs like 3DS max, MAYA are often used to build the model. But in that way, there also exist some problems like heavy workload or high cost[1]. With the development of technology, 3D modeling process are constantly simplified. Photo scan technology is one of those technology which can make modeling process easy[2]. Now we can through dense point cloud to rebuild the target object[Fig. 1].

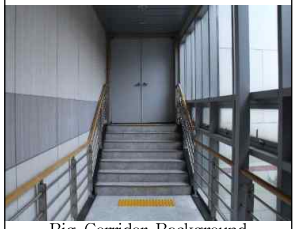


[Fig. 1] Dense Point Cloud

In many softwares which the model is built from the point cloud, the most famous software is Agisoft photoscan. Agisoft photoscan can also process small target and large target, as small as toy or archaeological objects; as large as building or topographic maps[3]. Just importing the target's photos which have a certain overlap chance into the soft, then the soft can auto built the sparse cloud, dense cloud, mesh model and texture[4]. The principle of photoscan modeling mode is through photos to get the point cloud then rebuild the 3D model. Point cloud means target surface's set of points[5]. There are many messages in the point cloud, include coordinate data, intensity and color information (RGB). Point cloud registration is built on neighbor point which has a certain degree of overlap[6]. In the 3D or 2D space, point cloud registration's theory is to find the same point from different photos, count those points' coordinate, then realize integrated them to be a mesh model[7].

Now we try use the software and set experimental groups <Table 1> to find photo scan modeling mode's effective design method and matters need attention. Meanwhile try prove photo scan modeling mode is effective and advanced.

<Table 1> Experimental Setting

Group	Target Object	Times	The Condition of Each Single Experiment		
Group 1	 Small Human Figurine	5	Use 9 photos	Each two adjacent photos have fixed angle	
			Use 17 photos	Each two adjacent photos have fixed angle	
			Use 25 photos	Each two adjacent photos have fixed angle	
			Use 49 photos	Each two adjacent photos have fixed angle	
			Use 49 photos	Each two adjacent photos have random angle	
Group 2	 Big Corridor Background	6	Use 10 photos	Each two adjacent photos have fixed angle;	Single Camera Position
			Use 18 photos	Each two adjacent photos have fixed angle;	Single Camera Position
			Use 26 photos	Each two adjacent photos have fixed angle;	Single Camera Position
			Use 50 photos	Each two adjacent photos have fixed angle;	Single Camera Position
			Use 50 photos	Each two adjacent photos have fixed angle	Two Camera position Each Camera Position take 25 photos
			Use 200 photos	Each two adjacent photos have random angle	Two Camera Position Each Camera position take 100 photos

2. Experiment method

The experiment is divided into two group, one group is research for small target object modeling, and another one group is research for big background modeling, all experiments use 2D photos to build 3D model.

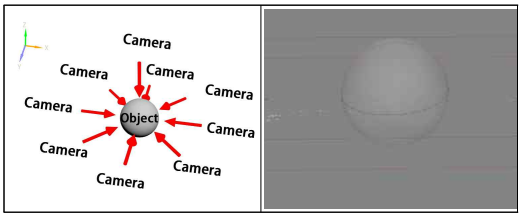
The first experimental group's target is small human figurine. Experiment method is to photo the target 5 times in different way, find the best and the most efficient way. The subject is white clay human figurine, 17cm high, and 7cm arms span.

The second experimental group's target is big corridor background located in Dongguk University. Experiment method is to photo the background 6 times in different way, find the best and the most efficient way. The selected corridor is half wall half glass windows, and the front end with an iron gate, the back end with few stairs and an another iron gate. The corridor is 8.85 meters long, 1.5 meters wide and 3.3 meters high.

In experiment, we use CANON EOS 60D DSLR camera: camera gear M mode, photo size 5184 pixel x 3456 pixel. In experiment, Agisoft photoscan software's setting is: align photos level set to "medium"; fit k4 camera; build dense cloud level choose "medium"; build mesh level is "medium", texture size choose 4096 mm x 4096 mm[8].

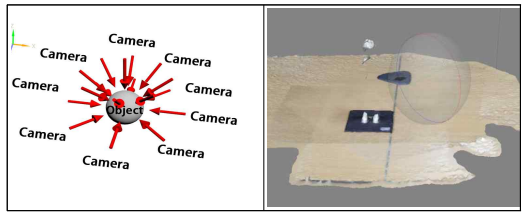
3. Experimental Result Record And Analysis

3.1 The First Experimental Group



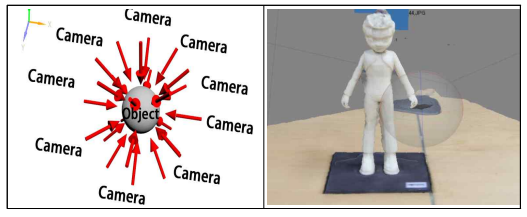
[Fig. 2] Through 9 photos to modeling

The first experimental group's first experiment result[Fig. 2] is: through those photos' dense cloud software cannot build any model, because adjacent shooting photos do not have enough recognizable overlapping points. So the target object's photos need a certain amount of recognizable overlapping points, adjacent shooting photos' shooting angle should be below 90°.



[Fig. 3] Through 17 photos to modeling

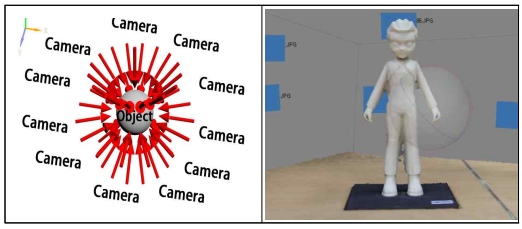
The second experiment result[Fig. 3] is: target model only modeled hair part and boots part, but the floor under the target model is complete modeled. The second experiment added top sides' shooting information on the basis of first experiment. So the floor is clearly appeared, but to the target object self, only modeled hair part and boots part, because only top side's photos have enough recognizable overlapping points and the other side is lack of enough originally photo information.



[Fig. 4] Through 25 photos to modeling

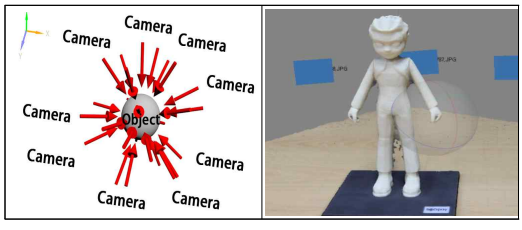
The third experiment result[Fig. 4]] is: target model was nearly complete modeled, but the surface part is not smooth, have many mesh fragments. The third experiment added bottom sides' shooting information on the basis of second experiment. So this time we successfully built the subject model, but the detail parts' information are still insufficient, it resulted the finished model's surface is very rough and lumpy.

According to the results of the third experiment, modeling a single object's model minimum need to shot 26 photos through photo scan modeling mode. (In the experiment, we used 25 photos because of we don't need to model the bottom of boots, so one bottom view photo can be omitted.)



[Fig. 5] Through 49 photos to modeling

The fourth experiment result[Fig. 5] is: completely built all target model, the surface is smooth, but have a little few mesh fragments. The fourth experiment's result is more exact than the third experiment. In making process, use 22.5°angle difference to shooting 16 directions, every direction shot upper side , middle side and lower side, according to this way, we can get much more recognizable overlapping point, through those points we can build high quality dense cloud. At last, through those dense cloud registered we combine the model. This time the model's surface is smooth. But the target human figurine is not simply regular geometry, it exists many blind spots. So, we can see, under the jaw, in the underarms, and between the legs there exist some mesh fragments. It is because blind spots result in some errors in the process of building point cloud and dense cloud registration.

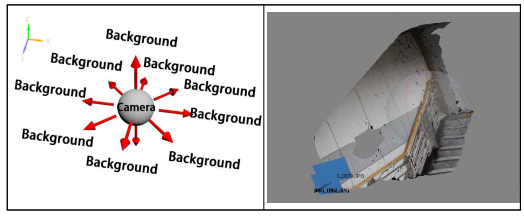


[Fig. 6] Through 49 random photos to modeling

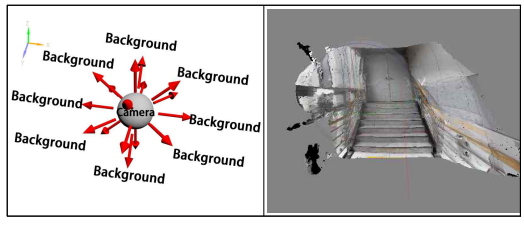
The fifth experiment result[Fig. 6] is: completely built all target model, the surface is smooth, have a little few mesh fragments between human figurine model's legs. Compared with the fourth experiment, the fifth experiment reduced regularity, added randomness. Because in the front of the target object's shot times are more than the target's back photos, the model's front is very clear and very smooth. The mesh fragments under the jaw, in the underarms, and between the legs are obviously decreased. The drawback is texture in back side is a bit darker than in the front. Totally, it has more advantages than the fourth experiment. Therefore, in the photo scan modeling process, adjacent photos' shooting angles don't need a fixed angle, just round the target as a sphere and below 90° then can get the finally model.

3.2 The Second Experimental group

The second experimental group's first experiment result[Fig. 7] is: just get an incomplete corridor model and it is close to a plane. It is also because adjacent shooting photos do not have enough recognizable overlapping point. It needs more photos.



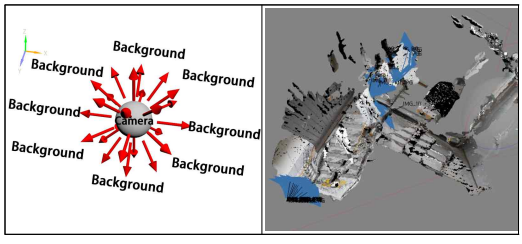
[Fig. 7] Through 1 camera 10 photos to modeling



[Fig. 8] Through 1 camera 18 photos to modeling

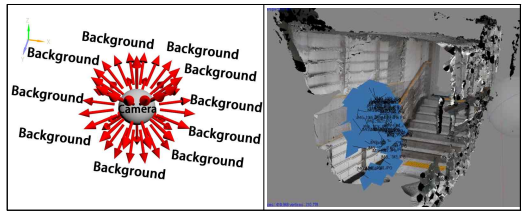
[Fig. 9] Sparse Cloud Modeling

The second experiment result[Fig. 8] is: only get corridor's stairs end part model, and that model is very flat, just stairs part have a little three dimensional feeling. The second experiment added 8 shooting angel, but only get the stairs end part model. According to this time's experiment, we can guess Agisoft Photoscan software has automatic filtering ability and automatic selection ability. If both ends have several point cloud, but one end is dense, another one end is sparse, the software will select only dense part to prevent sparse cloud interfere model's fineness. In order to verify that guess, we added an additional experiment: open software setting, select sparse cloud to add all sparse point clouds into modeling process[Fig. 9]. By building the model, we also find model which owns both ends, but the model's fineness is very terrible.



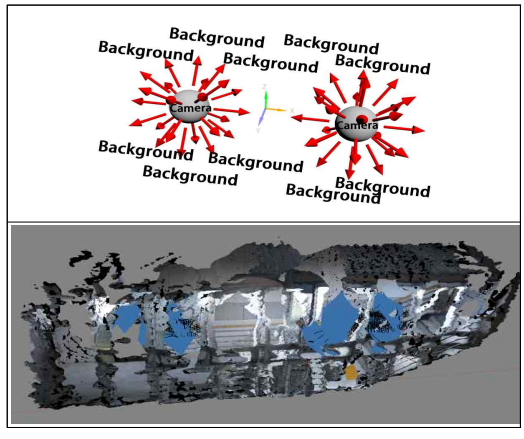
[Fig. 10] Through 1 camera 26 photos to modeling

The third experiment result[Fig. 10] is: both get corridor's two ends model, but the two ends location staggered, it is not modeled a straight corridor, detail parts are badly built. According to the third experiment's result we can see: for a long and narrow background like corridor, taking fixed angle shooting photos in the middle part of target background will get more information from both ends, but less information from left and right side. Through software's automatic selection ability, it only built two ends' model. And both ends' point cloud don't have any middle connection, it resulted in two ends use different xyz coordinate system when software aligns the photos. So in the model, two ends model parts' location appear error and mismatch. To solve the problem, we need to take more photos between left and right side to let soft build a continuous dense cloud.



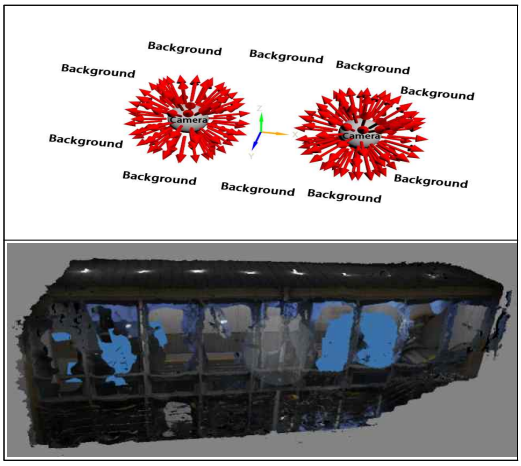
[Fig. 11] Through 1 camera 50 photos to modeling

The fourth experiment result[Fig. 11] is: corridor model nearly appeared, but lost two ends' part and many details, the whole model is fragmented. This time, we got much more point information from one single camera position's left and right side, but those information are not enough to build all corridor's model, just around camera position's sideward. The result model has more details around camera position, but has no detail in both ends.



[Fig. 12] Through 2 camera 50 photos to modeling

The fifth experiment result[Fig. 12] is: corridor model nearly appeared, although missing much detail, but it is better than the model through single camera position shot. Compared with the fourth experiment, the fifth experiment has the same photos number, but this time we use two camera position. According to the result, we can see this time, using photo scan modeling mode nearly modeled the whole corridor, only detail is not very clear. So, software can get more information from two cameras than from single camera, such as point position information and texture color information.



[Fig. 13] Through 1camera 200 photos to modeling

The sixth experiment result[Fig. 13] is: corridor completely rebuilt, nearly got all corridor's detail, but lost all glass windows' detail. The sixth experiment uses two camera position, each camera position as a center sphere, to shot 200 photos, finally gets a model which have high fineness and many details. So we can see, in photo scan modeling mode, background modeling needs multiple camera position to take many photos according to the actual situation. And according to this time's result, we can also see this modeling mode's weakness is glass modeling, glass windows lost many details in the result. So, in actual application, modeling glass material object or background with many translucent bodies are not suit for usage of photo scan modeling mode.

4. Conclusion

Through those two experimental group's analysis, we conclude that photo scan modeling mode needs to follow these rules:

(1) When we model a small object, the object must not be translucent; must use object as a center sphere and take more than 26 photos; the adjacent two photo's shooting angle must below 90°.

(2) When we model a large background, the background must not have many translucent material bodies; must use multiple camera positions and must use camera self as a center sphere to take multiple sets photos; decide to take how many photos based on the background's size, more photos can build better point cloud; the adjacent two photos' shooting angle must below 90°.

[Fig. 14] Model After Post Process

And according to the whole experiment process, we conclude photo scan modeling mode has two huge advantages. The first advantage is high efficiency. In traditional manual modeling mode, skilled designer needs one day to build a model. Through those photo scan modeling mode, even people cannot operate 3D software also can build a model in 30 minutes[9]. Although those models often need some post process by Zbrush or other software[Fig. 14], it is also more effective than traditional mode[10]. The second advantage is low cost. If one does not have a DSLR camera, we also can take photos by cellphone. Building the point cloud does not need high resolution

photos[11]. And modeling through photos does not need labor cost, everyone can build a model by several mouse clicks[12]. Thus photo scan modeling mode is effective and advanced, even compared with traditional modeling mode, it is also excellent.

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곽 대 위(Guo, DaWei)

・2010년 2월 :광운대학교 미디어영상학부(문학사)
・2014년 9월 :동국대학교 영상대학원 멀티미디어학과(MFA)
・2016년 9월 ~ 현재 : 동국대학교 영상대학원 멀티미디어학과 박사과정
・관심분야 : VR, Contents Design, 3D Scan, Computer Animation, Visual Effect 등.
・E-Mail : tlookguo@hotmail.com

정 진 헌(Chung, JeanHun)

- 1992년 2월 : 홍익대학교 미술대학 시각디자인학과(BFA)
- 1999년 11월 : 미국 Academy of Art University Computer Arts(MFA)
- 2001년 3월 ~ 현재 : 동국대학교 영상대학원 멀티미디어학과 교수
- 관심분야 : VR, Contents Design, 입체영상, 3D Computer Graphic, Computer Animation, Visual Effect 등.
- E-Mail : evengates@gmail.com