Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 7, S. 447-451, 4, 2023

Araştırma Makalesi

IJANSER
https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 7, pp. 447-451, 4, 2023

Research Article

The image processing for creating 3D model in teaching computer science

Krisztina Czakóová

Department of Informatics/J. Selye University, Slovakia

(czakoovak@ujs.sk) Email of the corresponding author

(Received: 14 May 2023, Accepted: 30 May 2023)

(DOI: 10.59287/ijanser.789)

(1st International Conference on Contemporary Academic Research ICCAR 2023, May 17-19, 2023)

ATIF/REFERENCE: Czakóová, K. (2023). The image processing for creating 3D model in teaching computer science. *International Journal of Advanced Natural Sciences and Engineering Researches,* 7(4), 447-451.

Abstract – The subject of computer science can be implemented at every level of education. It offers a creative space for the modernization of education. The image processing and the creation of 2D and 3D models are an actual problem in computer science. The digital technologies and modern methods are useful in solving many tasks in this area. The paper presents procedures which are easy to implement in the teaching of computer science at secondary schools. We will focus on the creation of real spatial models of small objects. The mastering the curriculum is highly supported by the active involvement of students in creation of models. We have designed a teaching module for inclusion, the creation of a real model in the subject's content, by combination of project and problem-based teaching. Students learn by actively participating in solving partial problems. They can incorporate into the solution of real projects on the chosen topic. The project method allows students to work in groups and solve a complex practical tasks by practical activities. Our aim is to motivate students to mastering the curriculum via an active learning method "learning by doing", by represents a real problem from everyday life, by using modern (mobile) technologies. The ability to collaborate, learn by discovering and exploring influences the development of a learning strategies.

Keywords –Computer Science, Education, Image Processing, 3D Model, Creation

I. INTRODUCTION

We live in a knowledge society. With modern technologies we can process more information in a shorter time. Within the subject of computer science, we can use activating methods and work projects in classroom. Activating methods create space and opportunities for the modern constructivist learning process. We can show the idea of how adults actually use computers at work for implementing solutions for real problems of everyday life. Students can develop critical and responsible thinking and decision-making. The subject of computer science can be implemented at every level of education. It offers a creative space for the modernization of education. The ability to collaborate, learn by discovering and exploring influences the development of a learning strategies. Above all, students should develop their cooperation and communication skills. It is important that they learn to work together in groups to solve problems, be able to prepare work plans, specify subproblems, collect results and compile

them into an overall solution, as well as the need for self-education in further [1, 6-10, 12-15].

II. Content and Organizational forms of Computer Science at Secondary Schools in Slovakia

According to the documents of the International Standardized Classification of Education (ISCED), the content of the subject of computer science for secondary schools is mainly aimed at acquainting students with various types of data, their collection, storage, display, processing and presentation. It is important to acquire skills to be able formulate the problem, as well as to obtain information from appropriate sources, to find a solution and contexts. The students' effort should be primarily focusing on logical thinking, developing the creativity [1, 2].

The project method allows students to work in groups and solve a complex practical tasks by practical activities (problem, topic) associated with real life. The goal is to create an adequate product - project. The process of the project can be divided into several working phases. At the beginning, it is important to determine the goal. At the next phase is created a plan for the solution (responsibilities, work plan, method of presentation of results will be divided). At the end is the realization of the plan and publication of the project results.

In the next chapters we would like to present a teaching module for the introduction of modern technologies for image processing and creating a real model.

III. Materials and Methods

Nowadays, many students already have a smart mobile phone capable of creating simple videos. We will use captured videos and photogrammetry procedures to create models. The quality of the created model depends on the used software. We can also influence it by the way of obtaining the video sequence. It is required that the video should be created rather slowly, and not at a rapid pace. The subject must be visible from all sides (as well as from the top or bottom). The overlap of individual frame obtained from the captured video should be at least 2/3.

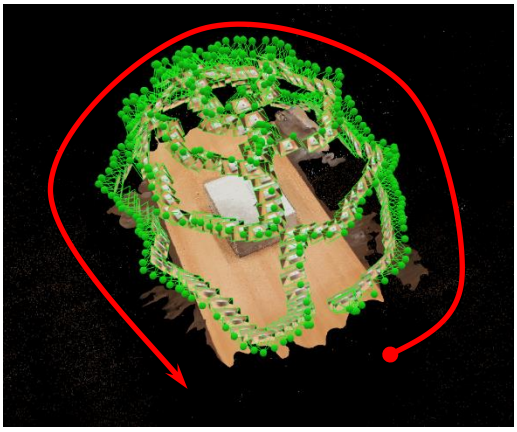

Fig. 1 The track created by video capturing the object

Software for image processing: There are several software products for measurement and modelling of the real-world through photographs. Among the paid products we would recommend the software Agisoft (known as Agisoft Metashape). We used the photogrammetric software for free. Pix4D mapper Pro mainly enables desktop and cloud image processing, generation of 3D Point Clouds and their classification, generation of 3D textured models as well as 2D measurements and 2D vector outputs [3, 4]. When importing a video, the software first requires us to set the number of frames (it is automatically selects from the video according to fps. On the Fig. 1 we can see the individual frames that the software selected from the imported video. Using photogrammetry procedures, the software processes the so-called Tie Points (from them the Point Clouds will be created). We can see this in Fig. 2.

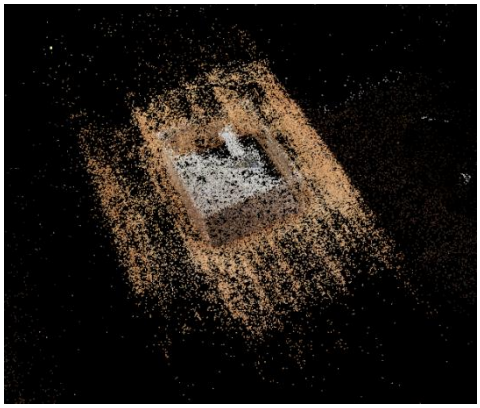

Fig. 2 The Tie Points for creating Point Clouds

Teaching module design: Method used during the teaching module is project based learning. Organizational form of education used during the teaching module is teamwork. Didactic tools: camera, mobile, software for create 3D model

(Pix4Dmapper Pro), computer (minimum requirement: 12 core processor, 32 GB RAM). The final product is a digital 3D model of a selected object.

Working phase description: The first step is to capture the subject (we recommend choosing a simple square object) by creating a video at a slow pace. During the shooting session check the sharpness of the images, as well as selecting the image stabilization function (video cameras and camcorders, as well as mobile phones already have this functions). We capture the object with the camera gradually from all sides by moving around the object (from the side, and from the top at an angle of 45°).

At the next working phase we can use the appropriate software to create a 3D model of the captured object (Pix4Dmapper Pro). We need to import video and set number of images that the software automatically selects from the video based on the fps. Subsequently, the software processes Tie Points. From those is created Point Clouds. The model of the object is created by using Triangle mashes. It doesn't have to be always strictly perfect. It often needs to be adjusted by manually removing the Tie Points and re-mashing. However, we must take into account that significant trimming of Tie Points can lead to the loss of the integrity of the object.

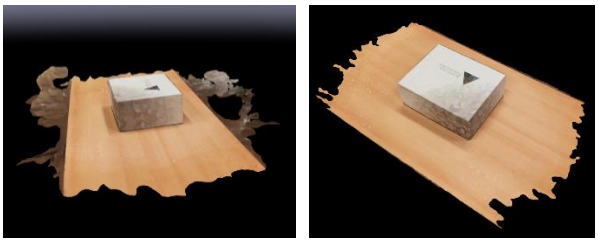

Fig. 3 Created model from 500 photos and the modified model (on the right)

If we reduce the number of photos/selected video frames to 500 while importing the video, then the model created by the software will still be acceptable quality for the overall modification of the 3D model [5].

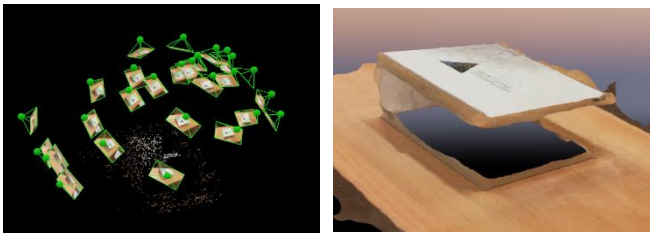

Fig.4 *Created model from 50 photos and the modified model (on the right)*

If we continue in reduce the number of photos, we can see in the Table 1 that the number of photos 100 appears to be insufficient to modify the 3D model. There is a risk of the so-called surface ripple effect (see on the Fig. 4).

Table 1. Result of the observation the model quality

Number of photos	**1000**	**500**	**250**	**100**	**50**
Quality of model	very good	enough good	good	with errors	very bad
Quality of modified 3D model	very good	very good	good	with risk of surface ripple	incomplete
Time for creation	10-12 hours	80 min	50 min	25-30 min	10 min

For smaller objects (the size of a smaller box or like) it is sufficient to set the number of photos in the range of 1000 to 250. It is enough for ensure good quality of the created 3D model.

IV. RESULTS

In the article we have shown that the creation of models is in a given way and quite effectively implementable into the teaching process. We can state that the given procedures are well applicable in secondary schools. Our practical experience from observation is well summarized by Table 1. We want to point out how the number of photos obtained from the captured video affects the quality of the 3D model.

V. CONCLUSION

Currently, it is probably impossible and unimaginable to exclude elements of ICT from the educational process. The creation of 3D models has become very popular nowadays. Acquiring photos and videos in today's digital age is not a challenge, nor is the cost of the required software for processing them. The development of computer

technology as well as the increase in computing power undoubtedly contributed to this. The results obtained may not only serve as a compulsory school task. It have other practical significance, such as 3D model printing, model archiving and the like.

REFERENCES

[1] K. Czakóová, O. Takáč, "The application of modern technologies for image processing and creating real model in teaching computer science at secondary school". *In. ICERI 2020 Proceedings of the 13th International Conference of Education, Research and Innovation*, DOI: 10.21125/iceri.2020.1330, pp. 6180-6187, Seville : IATED Academy, 2020. ISBN 978-84-09-24232-0. ISSN 2340-1095.

[2] (2015) State Pedagogical Institute, Computer science - Innovated state educational program (ISCED 3), Bratislava: Štátny pedagogický ústav, 2015. [Online] Available: https://www.statpedu.sk/

[3] Cs. Molnár, I. H. Jermyn, Z. Kató, V. Rahkama, P. Ostling, P. Mikkonen, V. Pietiainen, P. Horváth, "Accurate Morphology Preserving Segmentation of Overlapping Cells based on Active Contours," Scientific Reports, vol. 6, art. no. 32412, pp. 1-10, 2016.

[4] F. Alidoost, H. Arefi, "Comparison of uas-based photogrammetry software for 3d point cloud generation: a survey over a historical site," ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, vol. IV-4/W4, pp. 55-61, 2017.

[5] L. Kormoczi, Z. Kató, "Filling missing parts of a 3D mesh by fusion of incomplete 3D data," Advanced Concepts for Intelligent Vision Systems : 18th International Conference, ACIVS 2017, pp. 711-722, 2017.

[6] Végh L, Takáč O. ONLINE GAMES TO INTRODUCING COMPUTER PROGRAMMING TO CHILDREN. In: INTED2021 Proceedings. 15th International Technology, Education and Development Conference. IATED; 8-9 March, 2021 2021:10007-10015. doi:10.21125/inted.2021.2091

[7] Takáč O, Végh L. USAGE OF UAVS IN THE PROTECTION OF CULTURAL HERITAGE IN THE TEACHING OF COMPUTER SCIENCE. In: INTED2021 Proceedings. 15th International Technology, Education and Development Conference. IATED; 8-9 March, 2021 2021:9987-9992. doi:10.21125/inted.2021.2084

[8] Udvaros J, Takáč O. DEVELOPING COMPUTATIONAL THINKING BY MICROCONTROLLERS. In: ICERI2020 Proceedings. 13th annual International Conference of Education, Research and Innovation. IATED; 9-10 November, 2020 2020:6877-6882. doi:10.21125/iceri.2020.1474

[9] Štempeľová I, Takáč O. IMPLEMENTATION OF ELEMENTS OF INTELLIGENT AGRICULTURE IN INFORMATICS LESSONS WITH REGARDS TO THE SUPPORT OF INTERSUBJECT RELATIONSHIPS. In: INTED2023 Proceedings. 17th International Technology, Education and Development Conference. IATED; 6-8 March, 2023 2023:5968-5973. doi:10.21125/inted.2023.1571

[10] Takáč O, Végh L. CREATION OF 3D MODELS OF REAL OBJECTS IN THE TEACHING OF COMPUTER SCIENCE. In: ICERI2021 Proceedings. 14th annual International Conference of Education, Research and Innovation. IATED; 8-9 November, 2021 2021:5723-5727. doi:10.21125/iceri.2021.1291

[11] Végh L, Takáč O. MOBILE CODING GAMES TO LEARN THE BASICS OF COMPUTER PROGRAMMING. In: EDULEARN21 Proceedings. 13th International Conference on Education and New Learning Technologies. IATED; 5-6 July, 2021 2021:7791-7799. doi:10.21125/edulearn.2021.1590

[12] Gubo S, Kmet T, Molnar A, Takac O. A Multi-range Approach for Cultural Heritage Survey: A Case Study of a Medieval Church in Slovakia. In: 2020 IEEE 18th World Symposium on Applied Machine Intelligence and Informatics (SAMI). ; 2020:000117-000122. doi:10.1109/SAMI48414.2020.9108724

[13] Tusor B, Takáč O, Molnár A, Gubo Š, Várkonyi-Kóczy AR. Shape Recognition in Drone Images Using Simplified Fuzzy Indexing Tables. In: 2020 IEEE 18th World Symposium on Applied Machine Intelligence and Informatics (SAMI). ; 2020:129-134. doi:10.1109/SAMI48414.2020.9108735

[14] Takáč O, Végh L. POSSIBILITIES OF USING PHOTOGRAMMETRY IN THE TEACHING PROCESS. In: EDULEARN21 Proceedings. 13th International Conference on Education and New Learning Technologies. IATED; 5-6 July, 2021 2021:9237-9242. doi:10.21125/edulearn.2021.1860

[15] Annuš N, Takáč O. ALGORITHMIC AND SIMULATION-BASED TEACHING OF COMPUTER SCIENCE AND MATHEMATICS IN HIGHER EDUCATION. In: ICERI2022 Proceedings. 15th annual International Conference of Education, Research and Innovation. IATED; 7-9 November, 2022 2022:4904-4911. doi:10.21125/iceri.2022.1184

[16] J. Udvaros and N. Forman. (2023) Artificial Intelligence and Education 4.0, INTED2023 Proceedings, pp. 6309-6317. https://doi.org/10.21125/inted.2023.1670

[17] J. Udvaros, N. Forman and S. M. Avornicului. 2023. Agile Storyboard and Software Development Leveraging Smart Contract Technology in Order to Increase Stakeholder Confidence, Electronics 12, no. 2: 426. https://doi.org/10.3390/electronics12020426

[18] J. Udvaros, N. Forman, L. Szabó, K. Szabó (2022) THE IMPORTANCE OF TEACHING DRONES IN LOGISTICS, ICERI2022 Proceedings, pp. 3286-3290. doi: 10.21125/iceri.2022.0811

[19] Udvaros J. (2019). Teaching Object Oriented Programming By Visual Devices, eLearning and Software for Education 15 pp. 407-413. Paper: 7, 7 p. https://doi.org/10.12753/2066-026X-19-054

[20] J. Udvaros and O. Takáč. (2022) Technical IT solutions in teaching, INTED2022 Proceedings, pp. 4047-4052. https://doi.org/10.21125/inted.2022.1107

[21] O. Takáč, D. Hrubý, V. Cviklovič. Possibilities of navigation of mobile agricultural robots on the principle

of the geometrical objets detections. 1, Bucharest : UNIV Agricultural Sciences & Veterinary Medicine Bucharest, 2011. p. 206-208. ISSN: 2284-7995.