COMPUTER-ASSISTED SURVEYING EDUCATION USING 3D SIMULATOR

Yoichi KUNII [a], Hirofumi CHIKATSU [b], Tatsuya OHDAKE [b], Kunihiko ONO [a]

[a] Japan Association of Surveyors, 1-3-4, Koishikawa, Bunkyo-ku, Tokyo, 112-0002, JAPAN
kunii@geo.or.jp, ono@jsurvey.jp
[b] Department of Civil and Environmental Engineering, Tokyo Denki University,
Ishizaka, Hatoyama, Hiki-gun, Saitama, 350-0394, JAPAN
{chikatsu, ohdake}@g.dendai.ac.jp

Commission VI

KEY WORDS: Simulation, Education, Learning, Computer, Surveying, Design, Error, Three-dimensional

ABSTRACT:

In order to support self-paces learning of field survey practice and error concepts, 3D surveying simulator was developed by the authors. Contents of the 3D surveying simulator are traverse and leveling survey, and each kind of survey can be simulated. In addition, several procedures for each survey can be experienced; e.g. points setting, measurement of angle and distance and so on. Notwithstanding whether or web-based environment, the use of 3D surveying simulator allow students to learn design, practice and error concepts of survey at their own space. This paper will describe the 3D surveying simulator. Furthermore, the simulator was used for lecture of university, and evaluates the simulator under questionnaire for students.

1. INTRODUCTION

Recently, surveying educations in many universities and colleges are expanded for involving new technologies which are GPS, GIS, remote sensing and digital photogrammetry. However, in order to prevent declination of academic ability for engineering students in Japan, the trend for curriculum constitutions in some universities are prioritized fundamental or social educations. Therefore, the curriculums of surveying education are decreased in such universities.

In these background, the lecture of field survey practice couldn't be mastered enough surveying techniques. In addition, there are some issues for the field survey practice that influence of weather, requirement of expensive equipments and so on. Furthermore, error concepts for measuring are into black box due to simplification of the operation for recent technical innovation.

On the other hands, some study support systems which utilize recent communication technology have been receiving more attention; e.g. debate learning support system (Obayashi, et al., 2002), web-based field survey practice simulator (Shortis, 2001), environmental learning based on mixture of real and virtual experiences (Okada, et al., 2004) and so on.

In these circumstances, in order to support self-paces learning of field survey practice and error concepts, 3D surveying simulator was developed in this paper. Notwithstanding whether or web-based environment, the use of the 3D surveying simulator allow students to learn design, practice and error concepts of survey at their own space.

This paper will describe the 3D surveying simulator and evaluate the simulator under questionnaire.

2. 3D SURVEYING SIMULATOR

The 3D surveying simulator is constituted 2 kinds of survey which are traverse and leveling survey. This paper describes the simulator mainly along the traverse. The operation flows for the traverse by the simulator are as follows.

2.1 Selection of Area and Equipment

The simulator prepares 3 kinds of measuring fields and 3 classes of total stations, and the students can select from them in the main menu, and survey simulation can be performed on own situation. Figure 1 shows a main menu window for the simulator.

Figure 1. Main menu

2.2 Point Setting

Some measuring points for the traverse are set on the selected field, and traversal network is constituted automatically. Figure 2 shows the measuring points and the traversal network. However, each neighbouring point should be viewed for traverse. Therefore, the point setting operation should be considered topographical undulation and occlusion. Therefore, the students can study importance of the point setting operation. Figure 3 shows confirmation of viewing.

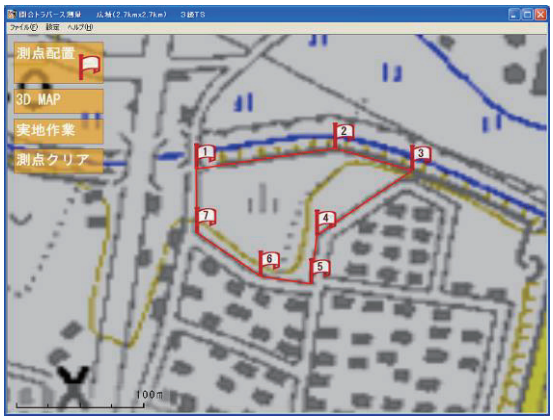


Figure 2. Measuring points and traversal network

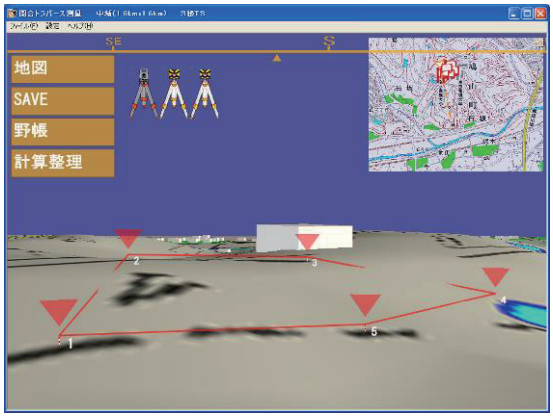


Figure 3. Confirmation of viewing

2.3 Equipments Setting

The total station and reflectors are set at each measuring points, and distances and angles can be measured. Figure 4 shows operation for setting of equipments. However, centripetal and leveling operation should be performed before these measurements in the simulator. Therefore, the students can study similar to real operation by using the simulator. Figure 5, 6 shows centripetal and leveling operation.

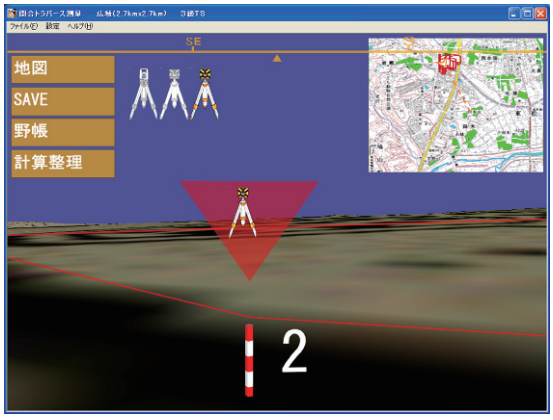


Figure 4. Setting of equipments

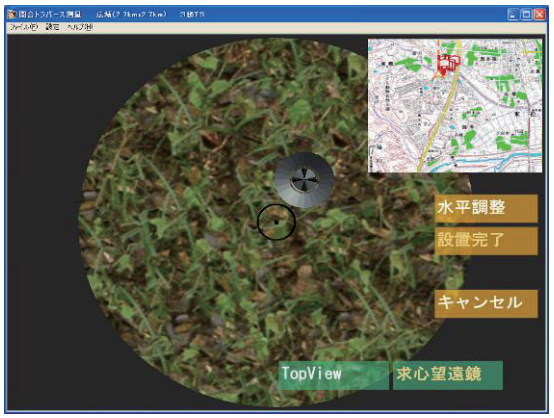


Figure 5. Centripetal

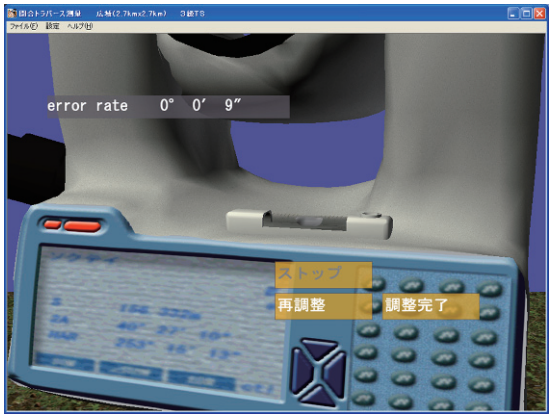


Figure 6. Leveling

2.4 Measurement of Distances and Angles

The measurement of distances and angles for traverse can be experienced by the simulator. The students can experience not only operation of the equipments but also generation of some kind of errors which are collimation, pointing and centripetal. In addition, accuracy for the distances and the angles are varied for the selected class of the total station. Therefore, error concept also can be studied by the simulator. Figure 7, 8 shows collimation of the reflector by peep sight and telescope.

Figure 7. Collimation by peep sight

Figure 8. Collimation by telescope

2.5 Movement of Equipments

The total station and reflectors are moved to next point, and repeating these procedure to the last point. After the surveying for all points, ratio of closure, error of closure and area are calculated, and the students can evaluate own results.

2.6 Leveling Survey

The simulator also can be experienced leveling survey. Figure 9 shows collimation of a staff by leveling telescope. The staff is moved to up and down, and the scale is read by the student. Nevertheless, the operation of points and equipment setting and so on are almost same method to the traverse.

Figure 9. Collimation by leveling

3. SURVEY PRACTICE BY "3D SURVEYING SIMULATOR"

The survey practice was lectured by using the simulator in Dept. of Civil and Environmental, Tokyo Denki Univ., Japan. The lecture of the survey practice was performed 15 units in a semester, and the simulator was used in 3 units out of those units. The simulator for leveling and traverse survey were used in the lecture respectively, and all of class (120 students) were operated by using own PC. Figure 10 shows lecture scene by using the simulator.

The practice for leveling was performed as an establishment of new benchmark. Figure 11 shows the simulator of leveling. These red square points are existing benchmarks, and "P" is a new point. The students selected any 3 benchmarks, and altitude for the point P was measured by leveling survey for 3 routes from selected benchmarks to point P. Furthermore, in order to evaluate own results and study error concept, most probable value and root mean square error for the altitude of point P were calculated for own results by each student. Figure 12 shows the root mean square error and number of students.

On the other hand, the practice for traverse survey was performed specific area shown in figure 13. The student learned not only equipment operation, but also points and equipment setting or error concept. Furthermore, the grade of the subject for each student was evaluated under the ratio of closure. Therefore, in order to acquire acceptable results, the students tried so many times in the lecture. Figure 14 shows the ratio of closure for the traverse and number of students.

Figure 10. Lecture by using "3D surveying simulator"

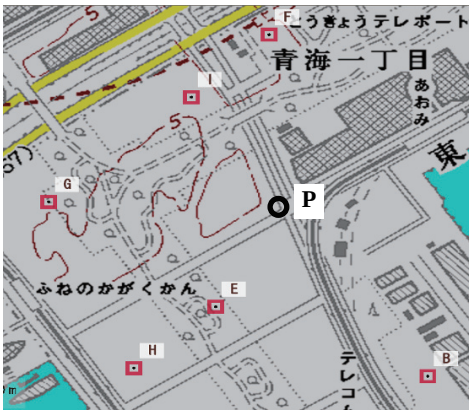


Figure 11. Benchmarks and new point

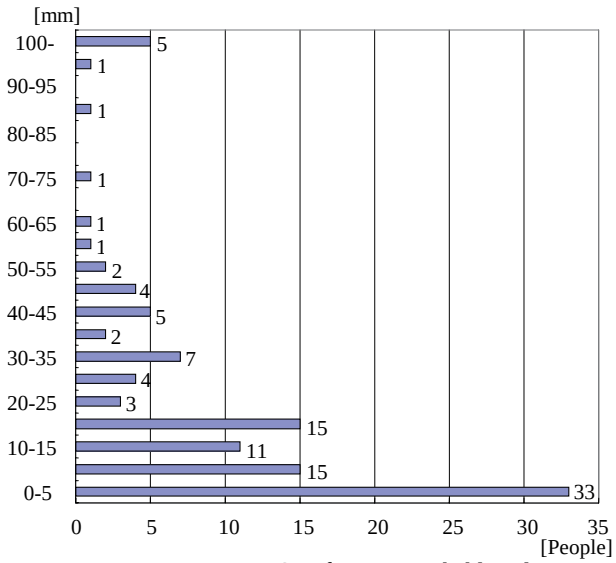


Figure 12. R.M.S.E. for most probable value

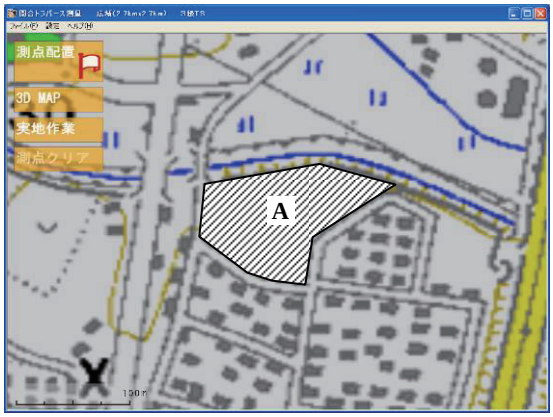


Figure 13. Area for traverse

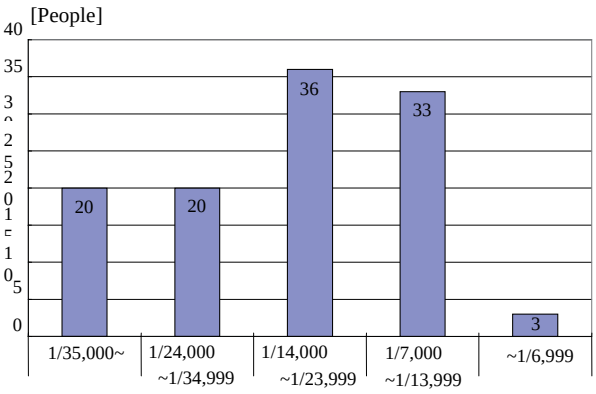


Figure 14. Ratio of closure

4. QUESTIONNAIRE FOR "3D SURVEYING SIMULATOR"

After the lecture, a questionnaire for the simulator was performed for the students. Figure 15 shows questions and results of the questionnaire. Some results for the questionnaire are as follows;

(Q1) Was the "3D surveying simulator" useful for understanding of methods and subjects of surveying practice?
Useful: 94%, Useless: 6%

(Q2) Was the "3D surveying simulator" useful for study of error concept and processing of surveying results?
Useful: 78%, Useless: 22%

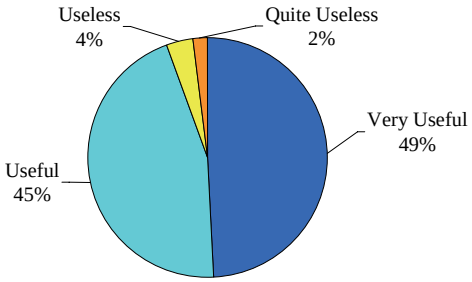
(Q3) How was an impression for the "3D surveying simulator"?
Interesting: 78%, Uninteresting: 22%

(Q4) Did you use the "3D surveying simulator" not only lecture of the university?
Yes: 65%, No: 35%

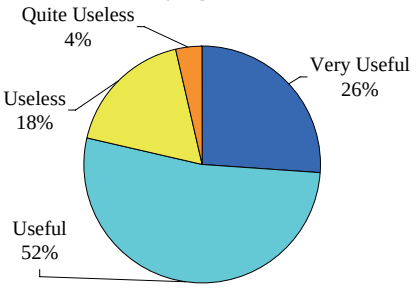
For these results, the simulator was useful for understanding of method and subjects for almost students, and error concept and processing of surveying results were also understood for many students. Furthermore, the impression for the simulator was answered "interesting", and the simulator was used not only lecture by many students. Therefore, the students can study survey technology and error concept independently, and purpose for development of the simulator was realized.

On the other hand, 6% students who answered "Useless" for Question 1 answered also negatively for other questions. It is expected that such students couldn't operate the simulator smoothly due to spec of own PC. However, the simulator was impressed "Useful" for 94% students, and it can be said the simulator is efficiently for surveying education.

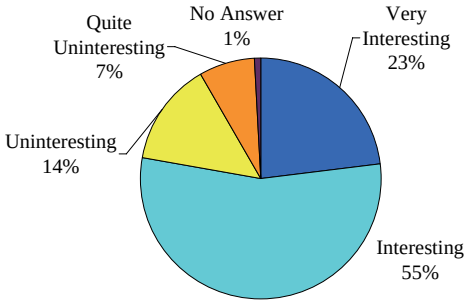
(Q1) Was the "3D surveying simulator" useful for understanding of methods and subjects of surveying practice?



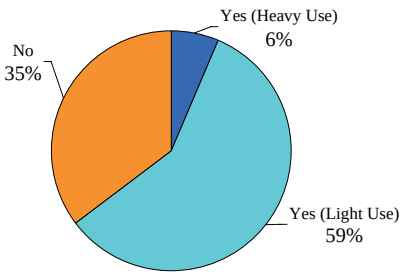
(Q2) Was the "3D surveying simulator" useful for study of error concept and processing of surveying results?



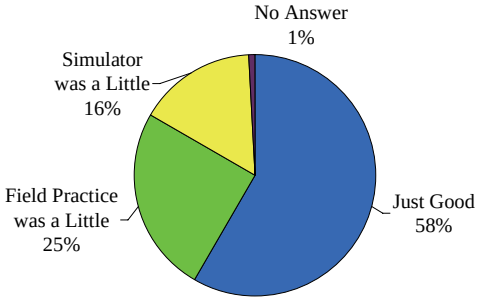
(Q3) How was an impression for the "3D surveying simulator"?



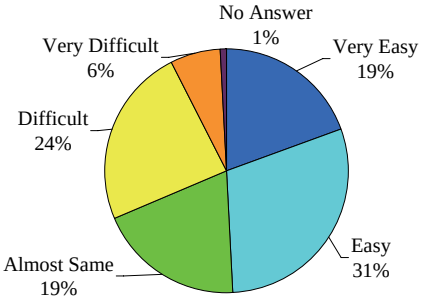
(Q4) Did you use the "3D surveying simulator" not only lecture of university?



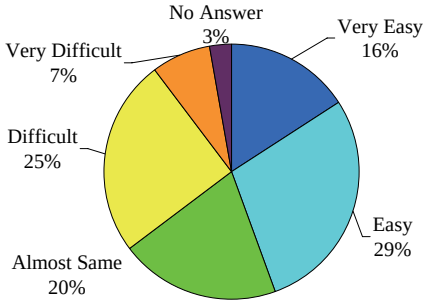
(Q5) How was a balance of number of units between field survey practice and the simulator?



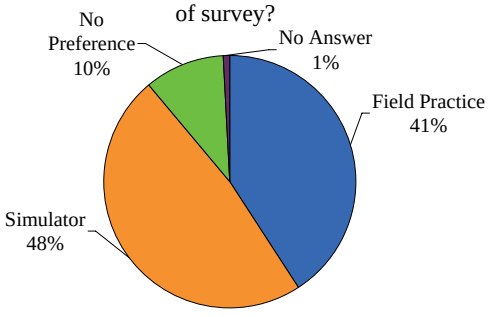
(Q6-1) How difficult was the simulator used than field survey practice? (Leveling)



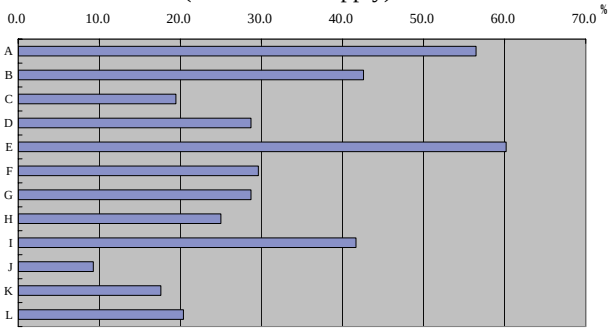
(Q6-2) How difficult was the simulator used than field survey practice? (Traverse)



(Q7) Which field survey practice or simulator should be learning earlier for easy understanding of survey?



(Q8) Please select the merit of the simulator (Select all that apply)



A: Easy understanding for contents of field survey practice
B: Virtual experience for field survey practice
C: Learning for error concept or processing of surveying results
D: Possible to review and preparation
E: Not influence for environment (whether, hot/cold, sunset)
F: Possible to learning anywhere
G: Possible to learning without survey equipment
H: Possible to retry easily for failure
I: Automatic calculation for results
J: Available for learning of PC operation
K: Like a game operation
L: Possible to learning alone

Figure 15. Results of the questionnaire

5. CONCLUSIONS

This paper investigates development of the "3D surveying simulator" for support self-paces learning of field survey practice and error concepts. In addition, the lecture of field survey practice by using the simulator was performed for the students, and the questionnaire for availability of the simulator was performed. As a result, the simulator was useful for understanding of method and subjects, and error concept and processing of surveying results were also understood for many students. Consequently, the students can study survey technology and error concept independently, and purpose for development of the simulator was realized.

As further works, addition of some contents for the simulator is still issue (e.g. surveying item and area); in particular, function for cost-effectiveness learning should be added on next version.

References from Journals:

Obayashi, F., Yamamoto, A., Ito, K., Shimoda, H. and Yoshikawa, H., 2002. A Study of Learning Support System for Integrative Study, *Journal of Information Processing Society of Japan*, Vol. 43, No. 8, pp.2764-2733.

Okada, M., Yamada, A., Yoshida, M., Tarumi, H., Kayugawa, T., Moriya, K., Collaborative Environmental Learning with the DigitalEE II System Augmenting Real and Virtual Experiences, *Journal of Information Processing Society of Japan*, Vol. 45, No. 1, pp.229-243.

References from Other Literature:

Shortis, M. and Woodhouse, N., 2001. Learning Design of Survey Networks using a Web-based Simulator, *Optical 3D Measurement Techniques V*, Vienna, Austria, pp.447-454.