

Development of GT-Simulator for Remote Sensing Education

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Abstract

Spectral measurement using spectral radiometer is one of the most basic and important ground truth measurements in remote sensing. By performing the spectral measurement, beginners of remote sensing can easily understand the concept of remote sensing. However, since spectral radiometers are usually quite expensive, it is not easy for most of the beginners in remote sensing to experience the measurement. In order to allow beginners to virtually experience the ground truth spectral measurement, the authors have developed a software package called GT-Simulator. GT-Simulator is accessible via internet from an Adobe flash player installed PC. GT-Simulator is a kind of roll playing game. By using GT-Simulator, beginners can learn the basic idea of ground truth spectral measurement.

1. Introduction

Remote sensing is a technology of monitoring the earth from various sensors on board airplanes and satellites. Due to the various earth environment issues, interest to remote sensing is increasing. Spectral measurement using spectral radiometer is one of the most suitable exercises for beginners to understanding the concept of remote sensing. Figure 1 shows a snapshot of spectral reflectance measurement using a spectrometer. Figure 2 shows examples of spectral reflectance curves acquired with a spectrometer. By using a spectrometer, one can understand the spectral reflectance characteristics of various objects and how we can identify certain object from the other with remote sensing technology. However, since spectral radiometers are usually quite expensive, it is not easy for most of the beginners in remote sensing to

experience the measurement. In order to allow beginners to virtually experience the ground truth spectral measurement, the Authors have developed a software package called GT-Simulator. GT stands for ground truth.

2. Development Concept

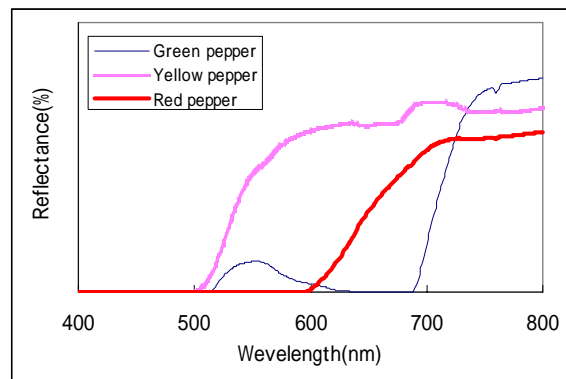
Nowadays, various kinds of educational materials on remote sensing are on the Internet. Most of them are text type[1,2] or interactive type[3,4] of materials with some Q & A functions. In general, interactive type can attract more users than text type. The authors have been developing a remote sensing educational material package called RS-Fun[5,6] under the concept of “edutainment: education and entertainment”. The idea is to interest users to learn things by introducing visualized game type functions to educational materials. The basic functions of GT-Simulator were taken over from RS-Fun development. The target users of GT-Simulator are beginners of remote sensing. The



Figure 1. Measurement with a spectrometer



(a) Red, yellow, and green pappers



(b) Spectral reflectance curves of the three pappers

Figure 2. Spectral reflectance measurement of peppers

basic ideas and principles on remote sensing and spectral reflectance measurement are explained in plain words with full of graphics so that even high school or lower grade students can understand. Especially, the spectral reflectance measurement procedures are prepared in a kind of role playing game to allow users to virtually experience the measurement. This is a new approach in remote sensing education.

3. System Configuration

GT-Simulator is developed using html language and Adobe Flash Professional 8 software. Flash Professional 8 is used as the authoring tool to provide interactive operations with various visual effects. GT-Simulator is installed on the web server of Tokai University, so multiple users can use GT-Simulator on their internet connected PCs with Flash player installed web browsers. The Flash player can be downloaded from Adobe homepage (<http://www.adobe.com/shockwave/download/>) on free of charge. Figure 3 shows the system configuration of GT simulator, and Table 1 shows the system requirement for running GT-Simulator.

4. Chapter and Session Structure

GT-Simulator mainly consists of three chapters which are;

- (1) Concept of remote sensing
- (2) How to measure spectral reflectance?
- (3) Let's try!

Though user can start from any of the three chapters,

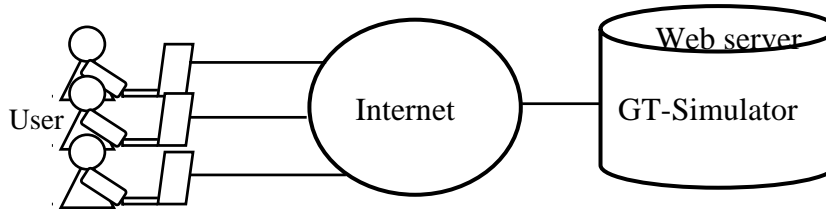


Figure 3. System configuration of GT-Simulator

Table 1. System requirement for running GT-Simulator

	CPU	RAM	Platform	Others
Windows	Intel®Pentium® 4, Intel Centrino®, Intel Xeon®, or Intel Core™ Duo (or compatible) processor	512MB or more	Microsoft® Windows® XP with Service Pack 2 or Windows Vista™ Home Premium, Business, Ultimate, or Enterprise (certified for 32-bit editions)	1,024x768 monitor resolution with 16-bit video card DVD-ROM drive
Macintosh	1GHz PowerPC® G4 or G5 or multicore Intel® processor		Mac OS X v.10.4.8	QuickTime 7.1.2 software required for multimedia features

(<http://www.adobe.com/products/flash/flashpro/productinfo/systemreqs/>)

working from (1) to (3) in sequential order is recommended. Chapter 1 is the introduction about remote sensing. If the user already knows about the concept of remote sensing, he or she can skip chapter 1 and start from chapter 2. Chapter 2 is explaining about how to measure spectral reflectance. Chapter 3 is a kind of game type chapter for the user to virtually experience spectral reflectance measurement. Followings are some detailed description of each chapter.

Each chapter consists of a series of sessions. Figure 4 shows the procedure of going through each session of a chapter. In each session, certain concept is explained with texts and graphics or images. Exercises are prepared occasionally to check the user's understandings. Most of the exercises are prepared like a game under the concept of edutainment.

Figure 5 shows the typical appearance of a Session. In this session 1-2, the reflectance property of objects is explained by thinking why an apple looks red under the sun. By pushing the buttons in the bottom of each page, user can go back one page or go to the next page.

(1) Concept of Remote Sensing

Chapter 1 explains about the concept of remote sensing in plane words. This Chapter consists of the following seven sessions.

- 1-1. What is remote sensing?
- 1-2. Reflectance property of objects
- 1-3. Application examples of remote sensing
- 1-4. What is reflectance?

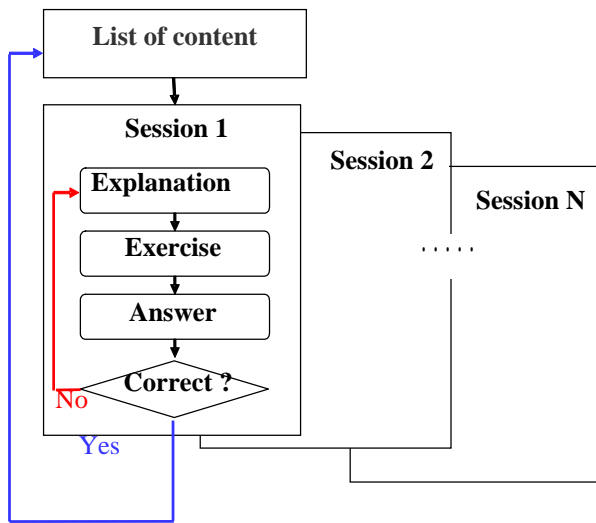


Figure 4. Procedure of each session

- 1-5. Electromagnetic spectrum used in remote sensing
- 1-6. Spectral reflectance curve
- 1-7. Spectral reflectance difference

Figure 6 shows an example of exercises. In this exercise, two spectral reflectance curves are presented. The user has to select a color ball which corresponds to each spectral reflectance curve. If the answer was wrong, “WRONG!” is displayed on the display as shown on Figure 6(b). This kind of interface does not only interest users, but also give users good motivation for doing exercise until they get true answers.

(2) How to measure spectral reflectance?

Chapter 2 consists of the following 5 sessions.

- 2-1. What is ground truth?
- 2-2. Reflectance and reflectance factor
- 2-3. Spectrometer and white board
- 2-4. Procedure of calculating reflectance factor
- 2-5. Weather condition consideration

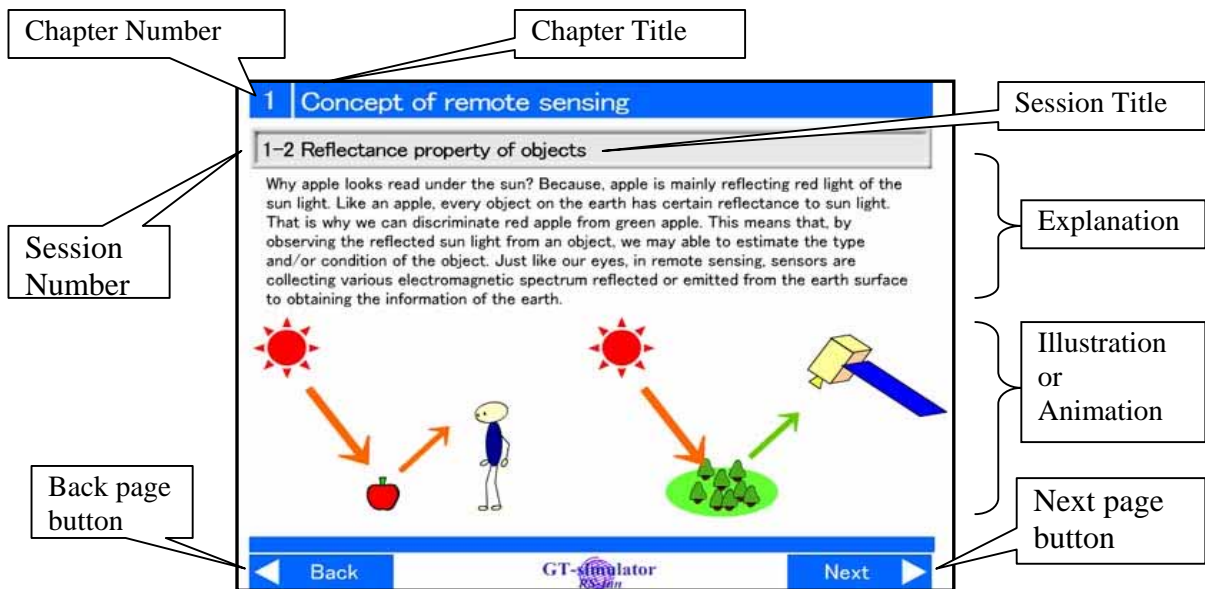
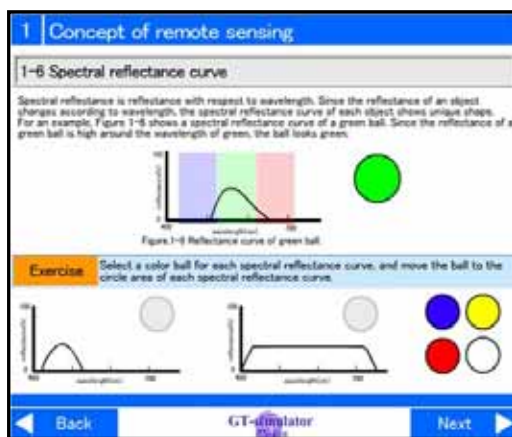
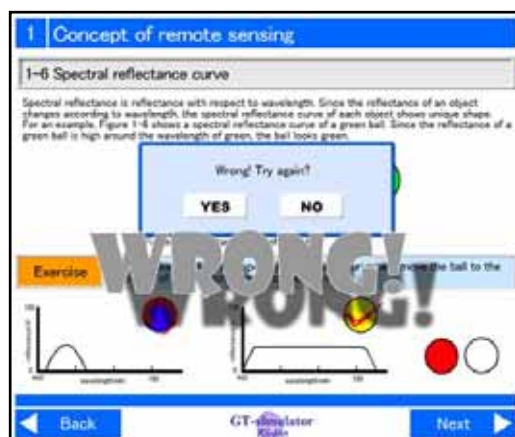


Figure 5. Typical layout of a session



(a) Question



(b) Answer check

Figure 6. An example of exercises

In this chapter, the concept of how the spectral reflectance factors are measured with spectrometer is explained. As shown on Figure 7, animation is used effectively to show the procedure of the measurement step by step. Importance of weather condition consideration is also explained in this chapter.

(3) Let's try!

Chapter 3 is for practice, and consists of the following four sessions.

- 3-1 Let's look at the satellite image for ground truth
- 3-2. Target objects for measurement
- 3-3. Spectral reflectance measurement
- 3-4. Spectral reflectance comparison

In this chapter, the users virtually can experience the spectral reflectance measurement.

Next page button

Figure 8 show the flow of the procedure of the operations in this chapter. We have selected Yoyogi Park of Tokyo, Japan as the test site, and the IKONOS image of the test site is used for a reference. The target objects for measurements are (1) Asphalt, (2)Grass, (3)Water, (4)broad leaf tree forest, (5)Bare soil, and (6)Tartan track. First of all the user learn how the targets look on the IKONOS image. Then, user has to assign each area for measurement(See Figure 9). User can zoom up the candidate areas for selection. Once the area for measurement is assigned, the spectral measurement of the target is performed with animation(See Figure 10)., and the reflectance curve of the target will be displayed(See Figure 11). After measuring the spectral reflectance of all the six targets, some exercises on the spectral reflectance comparison of the targets are given as shown on Figure 12. Through these exercises, user can check his/her understanding of the concept of identifying various objects with spectral information in remote sensing.

5. Conclusion

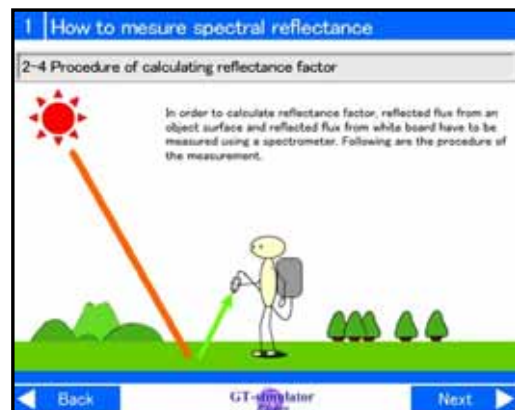
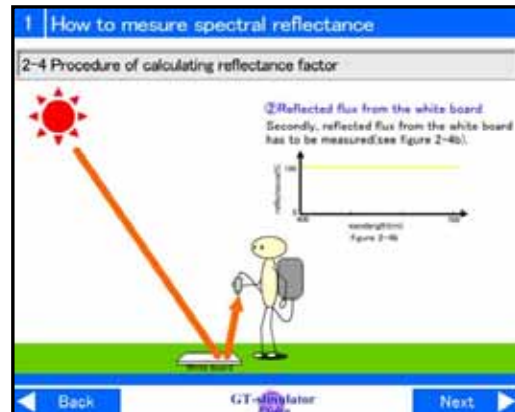
The Authors have developed a software package called GT-Simulator. GT-Simulator allows users to learn the basic idea of remote sensing and ground truth spectral measurement through the interactive operations of the software. By operating the software, user can virtually experience the spectral reflectance measurement like doing a role playing game.

In order to verify the use of GT-Simulator, the software was used at our center for educating a number of students who were beginners in remote sensing. After leaning about the spectral reflectance measurement with GT-Simulator, the time required for them to understand the operation of spectrometer at the practical ground truth training was much reduced compared with the students who did not use GT-Simulator in advance. The initial version of the GT-Simulator can be accessed at the following site.

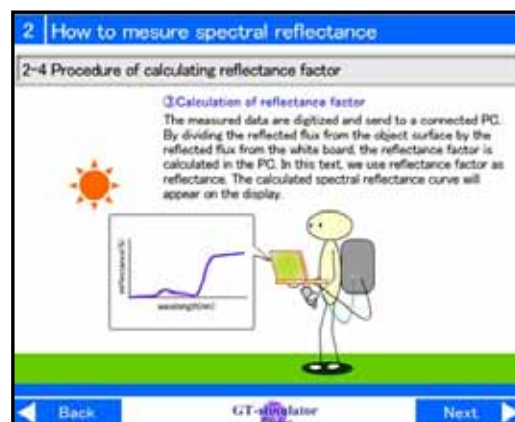
<http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/GT-Simulator/>

References

- [1]"Remote Sensing Tutorial (RST)" web page of NASA/GSFC (<http://rst.gsfc.nasa.gov/>)
- [2]"Fundamentals of Remote Sensing" web page of CCRS (<http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/fundam/fundame.html>)
- [3]"Image Interpretation Quiz" web page of CCRS (http://www.ccrs.nrcan.gc.ca/ccrs/learn/tutorials/iquiz/intro_e.html)
- [4]"IMAGERS" web page of NASA (<http://imagers.gsfc.nasa.gov/index.html>)



(b) Measurement of the white board



(c) Calculation of the spectral reflectance

Figure 7. A series of animation explaining the procedure of spectral reflectance measurement.

- [5] Cho, K. Matsuoka, R., Shimoda, H. and Matsumae, Y., RS-FUN: A web based interactive learning package for remote sensing education, Proceedings of the 25th Asian Conference on Remote Sensing , pp.721-726, 2004.
- [6] Cho, K., Komaki, A., Chujo, T., Tada, T., RS-fun for sharing educational materials on remote sensing, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.XXXVI-Part 6, (2006), pp.39-44.

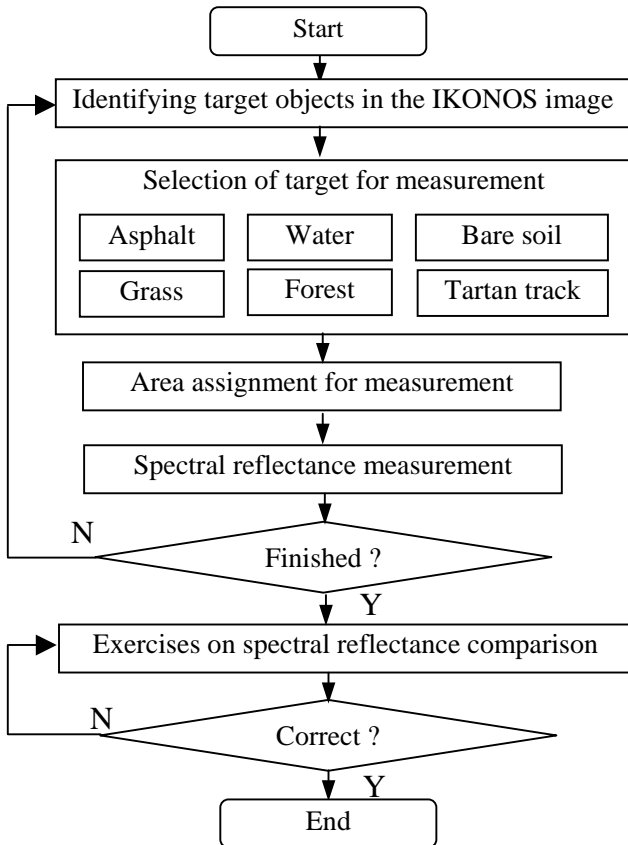


Figure 8. Flow of the spectral measurement

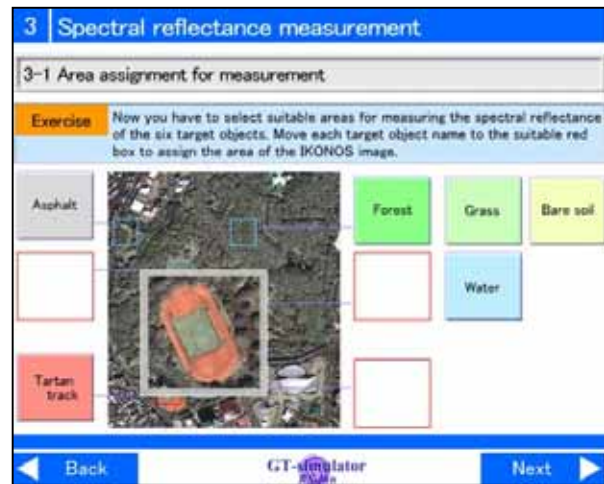
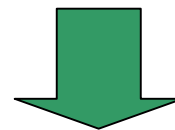
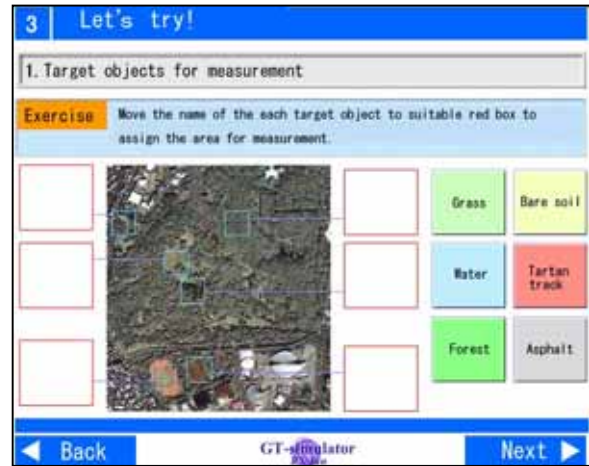


Figure 9. Area Assignment of target objects on an IKONOS image for spectral measurement

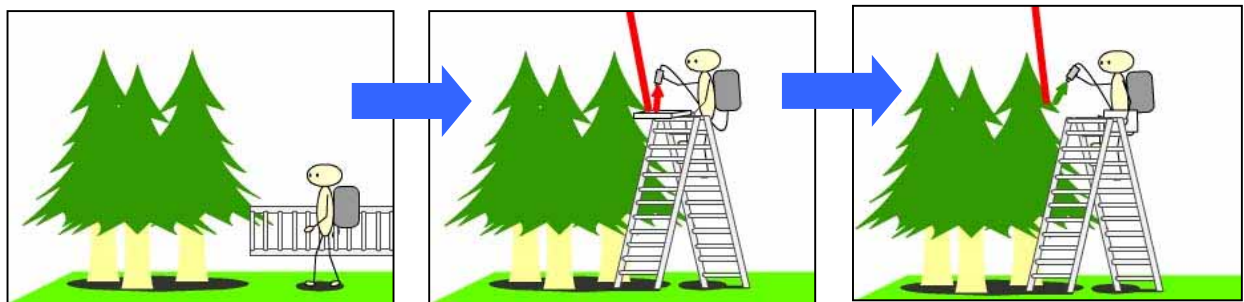


Figure 10. Animation of the spectral easurement forest

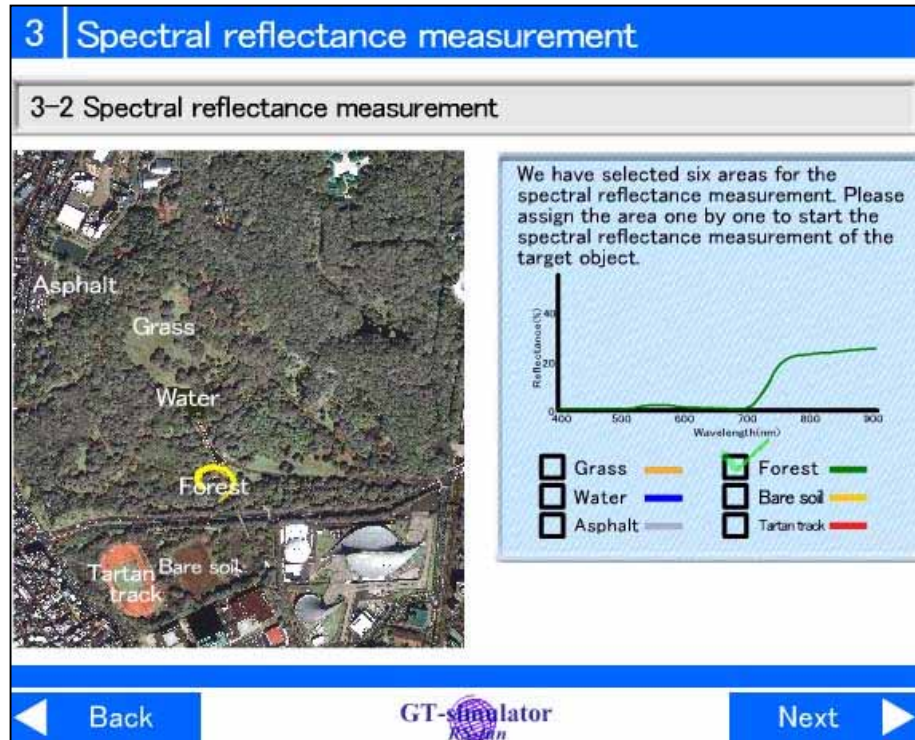


Figure 11. After the spectral reflectance measurement of forest, the spectral reflectance curve of the measurement will be displayed on the display. IKONOS image (C) JSI

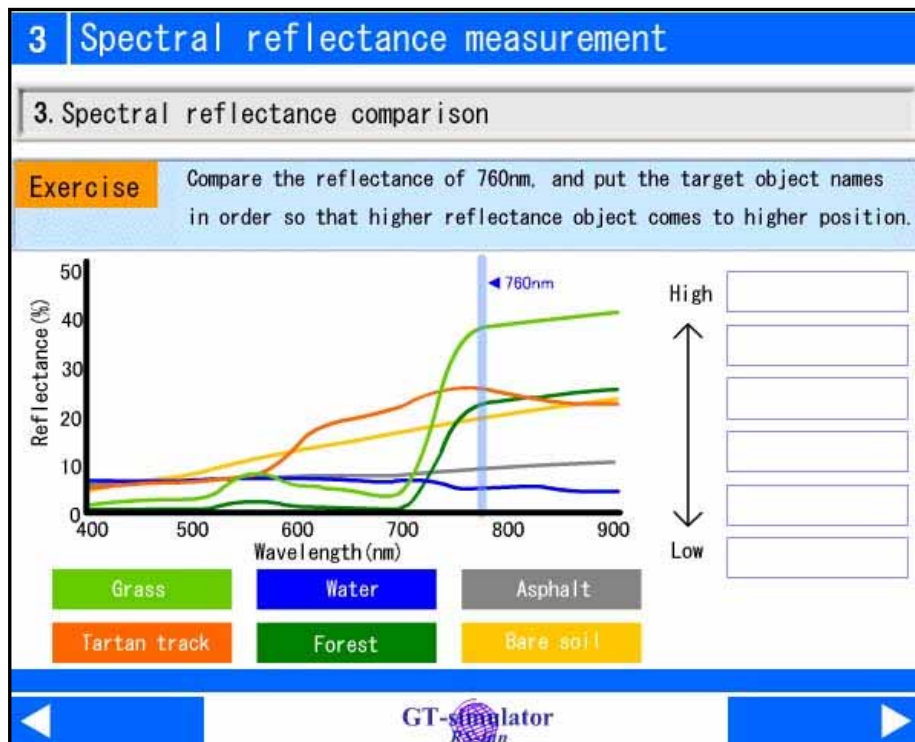


Figure 12. Exercise on spectral reflectance comparison