A NEW ONLINE COURSE ON RADAR POLARIMETRY AND POLSAR IMAGE PROCESSING

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ABSTRACT

Scheduled lectures and supervised laboratory sessions are the classical method of teaching radar polarimetry and polarimetric SAR image processing courses. This paper describes a new teaching method that uses multimedia and Internet technology in offering self-paced, web-based courses. Advantages and disadvantages of each method are presented.

Les cours magistraux et les séances de laboratoires supervisées à horaire fixe sont la méthode classique d’enseignement de la polarimétrie radar et le traitement des images RSO polarimétriques. Cet article décrit une nouvelle méthode d’enseignement qui utilise la technologie multimédia et Internet sous forme d’un cours Internet en auto-apprentissage. Les avantages et inconvénients de chaque méthode sont présentés.

1. INTRODUCTION

With development of the digital world and of new satellite sensors like RADARSAT-2 with its polarimetric capabilities, there is currently an increasing demand for remote sensing training, particularly in radar polarimetry. Traditionally, courses in these areas have been taught with theoretical material presented in the classroom, and practical applications delivered through supervised laboratory exercises. With development of Internet, multimedia and teaching software technology, it is now possible to teach radar polarimetry over the Internet through self-paced and web-based online courses. Since 1997, several online courses have been developed at the Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton (Canada) in GIS (FOR 4286: Géomatique avec ArcGIS), photointerpretation (FOR 3303: Photogrammetry, photointerpretation and remote sensing in forestry, FE 3306: Photo-interpretation for engineers) and in remote sensing (FOR 3313: Digital image processing in remote sensing, FOR 4303: Optical, thermal infrared and radar remote sensing) (http://extend.unb.ca/oalp/courses/). Each course is different from free online tutorials because it has theoretical quizzes, practical exercises and an exam. It also differs from software on-line helps and tutorials because it has a full explanation of theoretical concepts used in the software. Each course is available in both French and English, with FOR 3313 being also offered in Spanish.

This paper presents and assesses a new online course in radar polarimetry and polarimetric SAR images. The course, FOR 4304 Radar Polarimetry and Polarimetric SAR Images, has been offered since February 2008 in English and since December 2008 in French. It is offered not only to senior undergraduate UNB students, but also to the continuing education Open Access Learning Program (OALP) offered through the UNB College of Extended Learning. The latter is a self-paced, guided, independent study program, designed to offer UNB courses and services to individuals wishing to continue their formal education, but who currently are not served by conventional classroom-based courses. It is delivered through the Blackboard teaching platform. The image processing software taught in the practical exercises is the SAR Polarimetry Workstation (SPW) which is a module of PCI Geomatica, a professional image processing software made by a Canadian company, PCI Geomatics. The course is also available at the graduate level under FOR 6304. The course will use next year open source software, like PolSARpro.

2. ONLINE METHOD

Online course material is the only source of course information for students taking FOR 4304. The course is not delivered through scheduled lectures and laboratory sessions. It comprises the following eleven chapters:

I. Geometrical factors affecting single-polarized SAR images
II. Dielectric factors affecting single-polarized SAR images
III. Wave polarization (ellipticity, Poincaré sphere, Stokes vector, Jones vector)
IV. Multi-polarized non polarimetric SAR images (co-pol/cross-pol ratios)
V. Polarimetric scattering (filtering methods, Huynen fork)
VI. Matrix representations and image calibration and storage
VII. Polarimetric analysis (polarization synthesis, polarimetric response, pedestal height)
VIII. Polarimetric variables (fractional polarization, coefficient of variation, coefficient of correlation, phase difference)

IX. Coherent target decomposition (Pauli, Cameron, SSCM, Krogager, Huynen)

X. Incoherent target decomposition (van Zyl, Freeman-Durden, Cloude-Pottier, Touzi)

XI. Image classification (Supervised, unsupervised, hybrid)

While it is recommended that students complete one online chapter a week, i.e., theoretical quiz and practical laboratory exercise, some students can finish the course in one month, completing two or three chapters per week. When entering into the course via the teaching platform (Blackboard), students access the course home page displayed in Fig. 1.

![Figure 1. Course homepage](image)

The course home page has the following icons:

1. The “Syllabus” icon links to the course syllabus that describes course objectives, outline, modus operandi, and grading scheme.

2. The chapter and laboratory course material is accessible through the “All the Chapters” icon and “All the Labs” icon, respectively.

3. The “Glossary” icon gives access to the “Glossary of remote sensing terms” from the Canadian Centre of Remote Sensing, which is available both in French ([http://www.ccrs.nrcan.gc.ca/ccrs/learn/terms/glossary/glossary_f.html](http://www.ccrs.nrcan.gc.ca/ccrs/learn/terms/glossary/glossary_f.html)) and in English ([http://www.ccrs.nrcan.gc.ca/ccrs/learn/terms/glossary/glossary_e.html](http://www.ccrs.nrcan.gc.ca/ccrs/learn/terms/glossary/glossary_e.html)).

It also has the following tools:

1. To access the quizzes
2. To access the drop box for the lab reports
3. To search in the course
4. To search all the web links used in the course
5. To reach the transcript
6. Allowing the student locating himself/herself in the course

Practical laboratories make use of professional polarimetric SAR image processing software, SAR Polarimetry Workstation, which is a module of the image processing software GEOMATICA, developed by PCI Geomatics. Students are supposed to know the usage of image processing software like ERDAS, ENVI or GEOMATICA software, hence FOR 4304 is an advanced level course. Images used in the practical exercises can be downloaded directly from the course homepage. Laboratory reports have to be handled through the Assignment icon to the instructor.

Each of the theoretical and practical parts has specific learning objectives which allow its positioning in the whole course outline (Fig. 2). While laboratory reports require manual marking, theoretical quizzes are automatically graded. Indeed, theoretical quizzes consist of multiple choice or matching-type questions that include feedback for incorrect responses (Fig. 3). However, answering questions is not straightforward, as they usually require students to perform some computations or some procedures using course data and software. Quizzes can be reached using the “Assessment” tool of the Blackboard system. Besides the quizzes, students are invited to solve small self-corrected theoretical exercises when studying the theoretical part, like the one of Fig. 4.

![Figure 2. Example of lab objectives](image)
Online course delivery materials allow the teaching of additional background information, like difficult mathematical concepts or on radar polarimetry history, by hyperlinking the course material content to the Internet (Fig. 5). The final exam is designed as a project where students develop their own application.

Finally, besides ongoing e-mail contact with students, student progress can be tracked using the Blackboard system (Fig. 6).

3. COMPARISON OF CLASSICAL AND ONLINE METHODS

Online teaching offers advantages over the classical method (Table 1). Major advantages are related to course preparedness and flexibility in terms of timing, language and audience. Indeed, courses are not only offered to UNB-located students, but they are also offered throughout Canada and the world (Fig. 7). Also, with the online approach and its less time-consuming marking procedure, the instructor can more easily detect weak students and dedicate more time to them. This allows strong students to proceed on their own. Further, illustrations presented throughout an online course can be easily animated, which can make their messages more understandable. Online courses can also readily provide background information to the learners through linkages to relevant web-based pages.

Such advantages do not exist with classroom teaching. Main disadvantages relate to preparation time, impossibility of field teaching, lack of face-to-face interactions, limited types of quiz questions, and costs associated with online technology (teaching platform, web browser).

4. ACKNOWLEDGMENTS

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**Table 1. Comparison of classical and online teaching methods**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Classical method</th>
<th>Online method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactions</td>
<td><strong>Face-to-face</strong></td>
<td>Email and tracking system</td>
</tr>
<tr>
<td>Learning schedule</td>
<td>time tabled</td>
<td><strong>According to student’s own schedule</strong></td>
</tr>
<tr>
<td>Student progression</td>
<td>Depends on the classmates</td>
<td><strong>At their own speed</strong></td>
</tr>
<tr>
<td>Teaching language</td>
<td>Single</td>
<td><strong>Multiple</strong></td>
</tr>
<tr>
<td>Audience</td>
<td>Classroom</td>
<td><strong>Worldwide</strong></td>
</tr>
<tr>
<td>Student groups</td>
<td>Single</td>
<td><strong>Multiple</strong></td>
</tr>
<tr>
<td>Course preparedness</td>
<td>Can be poor</td>
<td><strong>well prepared, structured, organized</strong></td>
</tr>
<tr>
<td>Course preparation time</td>
<td><strong>Less time-consuming</strong></td>
<td>Time consuming</td>
</tr>
<tr>
<td>Instructor time dedicated to weak students</td>
<td>Low, because time is shared with strong students, and more time is needed for marking</td>
<td><strong>High, because strong students can go on their own, and less time is needed for marking</strong></td>
</tr>
<tr>
<td>Student attitude</td>
<td>Tendency to be passive</td>
<td><strong>Active learning experience, development of autonomic skills</strong></td>
</tr>
<tr>
<td>Course content</td>
<td>Limited</td>
<td>Unlimited, because of <strong>hyperlinks to the Internet</strong></td>
</tr>
<tr>
<td>Illustrations</td>
<td>Static</td>
<td><strong>Animated</strong></td>
</tr>
<tr>
<td>Field laboratory</td>
<td>Possible</td>
<td>Not possible</td>
</tr>
<tr>
<td>Quiz questions</td>
<td><strong>All types possible</strong></td>
<td>Only some types possible (short answer, matching, calculation, multiple, choice)</td>
</tr>
<tr>
<td>Class material</td>
<td>Chalk, blackboard, room</td>
<td>Teaching platform (BlackBoard), web browser</td>
</tr>
</tbody>
</table>

*(Bold-case items are considered as being an advantage)*