Remote sensing using microwaves – Does a web-based collaborative course serve a purpose?

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Keywords: teaching, web, microwaves

ABSTRACT: Teaching of remote sensing is a crucial part in the development and use of remote sensing. For the case of microwave remote sensing this is particularly true since the microwave interaction with different media is complex and often hard to understand. The microwave remote sensing technique is developing fast and many efforts have been done, through books, reports, CD-based material etc. to educate groups ranging from the broad audience, the educated users, students of earth sciences, scientists etc. Still the need is rather increasing to keep pace of the development and make useful the large investments made in satellite remote sensing. One possibility is to make more use of the web and to develop course material free of charge through combined efforts of teachers involved in courses in microwave remote sensing. An example of such course material has been made available on http://www.rss.chalmers.se/rsg/Education/RSUM and a collaborative development of this material towards a basic course at M.Sc. level is proposed.

1 INTRODUCTION

Presently we are in a transition period for microwave remote sensing, symbolised by the transition from the experimental ERS-1/2 ESA satellites to the more operational Envisat. The number of scientists and users is increasing but not always as fast as one would want in order to efficiently use the large investments associated with satellite remote sensing. High level products based on satellite observations are under development as part of the GMES proposal and ten different “service portfolios” covering a number of applications, sea ice, forestry etc. have just started with support from ESA. In parallel with this development the need for education is developing and changing. New groups of people need information about microwave remote sensing, not only those developing the sensors and new applications but more and more those using the technique for some application. Today too many are without an education that prepare them for the purpose.

Remote sensing is a cross-disciplinary subject covering wave propagation, system aspects, image processing, information extraction as well as understanding the geophysical aspects. Today the focus of the applications is very much on climaterelated aspects of global nature. This makes the subject interesting and suitable for a course e.g. at the end of the studies for the M.Sc. level.

The major problem with microwave remote sensing is the need for understanding of physical aspects of the interaction between the electromagnetic wave and the medium in combination with advanced technique. The educator’s dilemma is that he or she may be involved in developing the microwave remote sensing technique which in itself is changing fast and in a competitive manner and little time can be allocated to course developments. One alternative is to find a course book. Not that many suitable books exist for a relatively short course. Some books may be too advanced; some may be too old; some may be too extensive etc. Teachers often want to present their own research material and have very specific requests on the lecture material. At the same time they have limited time to develop the material and sometimes only viewgraphs are provided for the students, short course notes, journal papers etc. Students on the other hand often want low priced, concise lecture notes, and are not prepared to buy an expensive book, in particular if they only will use part of it or don't know if the book will be used in the future.
2 COLLABORATIVE PROJECTS ON THE WEB

One way to solve some of the problems is to develop and make available on Internet course material. By making it freely available it is easy to use. Teachers may find the material helpful and use part or all of the material depending on their needs. By having an agreement between interested teachers on how to update the material it can be improved and better adjusted to the needs of different teachers. Without comparison but still of interest one could point at the development of Linux. However, the number of people involved in microwave remote sensing may be too few for any related development.

3 REMOTE SENSING USING MICROWAVES

At a Nordic Research Summer Course in Remote Sensing using Microwaves in Sweden in 1984 it was discussed by some of the teachers to jointly develop course material but this was never fulfilled. Funding was needed and this was not possible to find at the time. Instead the different teachers developed material tailor-made for their needs and native language. The author of this paper has developed course material for an elective course given in the last year of the education at Chalmers University of Technology for the M.Sc. degree. Typically 12-17 students have taken the course yearly. The course is estimated to correspond to 3.5 weeks of full time work and consists of fourteen 2x45 minute lectures, seven 2x45 minute exercises and three application demonstrations consisting each of four hours. There are voluntary home exercises every week and there is a written exam at the end.

The students have been provided with copies of the lecture notes before the course started. The lecture notes are written more concisely than book material since it is presented in lecture form, but they also include parts not always found in books such as exercises and application demonstrations.

The course material is very much based on how microwave remote sensing developed through various research projects at the Department of Radio and Space Science, Chalmers University of Technology. The department has a history related to observations of the ionosphere, wave propagation in various media and focusing on radio astronomy at Onsala Space Observatory since the 1960s. The first remote sensing project goes back to 1975 and was related to oil spill detection using microwave radiometry. This activity was continued by projects on radiometer observations of humidity and temperature in the atmosphere for meteorological applications and later of ozone in the stratosphere. The European activities related to the planned ERS-1 satellite, which included a radar altimeter and synthetic aperture radar, changed the focus in the second half of the eighties from passive remote sensing technique with its roots in radio astronomy to active remote sensing technique. In Sweden applications like support of the ice-breaking in the Baltic (in order to make it independent of the cloud cover) were central and later extended to sea ice and climate change aspects in the Arctic region with participation in expeditions in 1991 and 1996. Boreal forest applications represented another area of interest with economical as well as climatologically applications in a Nordic country. The research projects have heavily influenced the development of the course material and the Ph.D. students have contributed a lot. As the lecture notes were intended to support the lectures the material was written in a concise form and not of the quality of a book. Physical fundamentals are stressed or at least intended to be stressed. Since the end of 2002 this material is available on the web in a beta version (http://www.sun.rss.chalmers.se/rg/Education/RSUM/) for free individual use, partly to find out if there is an interest for the material, to use it and to develop it. The material is available in pdf-format and consists of: lecture notes, exercises, demonstration applications, references to books, and Internet-sites with course material and illustration material. Some viewgraph material will also be added. A study plan for self-studies is included.

Further development of the course material will be dependent on requests from students and interests from other teachers. The course material provided is based on a full-time activity of the students of 3.5 weeks but an interactive course could be specialised to some specific application area.

4 ABOUT THE BETA-VERSION

4.1 Electronic and printed versions

Adobe pdf-files were created from the original Word-document with Acrobat Distiller and an index was also created by means of Acrobat Distiller. All the files are available on http://www.sun.rss.chalmers.se/rg/Education/RSUM.

Since individual printing of the material from the files is expected to be more expensive than printing centrally the material was printed in black and white and collected in hard cover together with the files from the web on a CD. The primary goal of the CD was to create the lecture notes in a searchable form and produce the images in color. The lecture notes and the CD were offered at a price of €25 but only for those signing up for the course at Chalmers. The price just covered the cost of the material and a small distribution cost for the student shop. It was a low cost also compared to lecture material sold for other courses.
4.2 Discussion forum

If no local teacher is available or students have problems of following the lectures it may be too hard to read the course material on ones own due to lack of inspiration from a teacher and fellow students and also due to the concise form of the lecture notes. This is also a basic weakness of web-based courses since the contact between the students and the teacher is an important part of the teaching process. For this reason there is need for electronic contacts between the teacher and the students and a discussion forum could be a solution. Since no special funding was available a low cost solution was searched for. One advice was to use the script language php 4.0.3 in combination with MySQL and a discussion forum software like that found on http://www.invisionboard.com. However some unavailable computer support was necessary to start such a project on the central server on which the lecture notes were available. In order to avoid delays the solution was to set up a discussion forum on Yahoo.com i.e. http://groups.yahoo.com/group/RSUM_group. This possibility was very convenient and very easy to handle and at no cost (reservations for risk of obtaining spam mail). It was explained in the beginning of the course that the idea with the discussion forum was that anyone could post a question and anyone could answer since the teacher may not have time and possibility to answer questions sufficiently fast.

4.3 Experience of the beta-version

The course was given January – February 2003 for roughly 40 students, approximately 15 regular students and 25 as part of a special master program in Advanced Techniques in Radio Astronomy and Space Science, see http://www.oso.chalmers.se/int-masters-prog/, a program given for the first time 2002/03. The regular students had the traditional Chalmers background while of the 25 special students some had Chalmers background but most quite variable background from different universities outside Sweden. The course was given in the traditional manner with lectures, exercises and application demonstrations. 19 copies were sold of the printed version of the lecture notes including the CD, illustrating that more than half of the students preferred the web-version, probably since this was free of charge.

The students were informed about the discussion forum and some few signed up during the course time. However, the possibility to ask questions this way was never used by the students. Neither did the students take the possibility to send questions directly by e-mail.

Since the course was given in the traditional manner with possibility for asking questions during and directly after lecture time the need for asking questions may have been small. Often questions, however, come up just before the exam, and then a discussion forum could be a good solution. However it seems the students never developed a habit of using internet for such aspects. It may be important to post necessary course material and course information together with the discussion forum in order to stimulate them to use the web-site. This year the course site and the site for the discussion forum were different.

A questionnaire about the course was issued at the end of the course. 17 students answered a number of questions of which some had relevance for the lecture notes. How many of those 17 bought the lecture notes is unknown. Some did not answer a question (N/A), while the rest graded according to the following instructions: 1 equals “strongly disagree” and 5 equals “strongly agree”, 1 represents the lowest and most negative impression on the scale, 3 represents an adequate impression, and 5 represents the highest and most positive impression. The result is given in the table below

<table>
<thead>
<tr>
<th>Question</th>
<th>N/A</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>The course compendium was useful</td>
<td>4</td>
<td>2</td>
<td>10</td>
<td>1</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have used other books to learn more</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1.8</td>
</tr>
<tr>
<td>The CD was useful</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The material on the web was useful</td>
<td>1</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The compendium was easy to read</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>The compendium was at right level</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>I think the compendium will be a useful reference in the future</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>

This year the course material was presented in a somewhat different order than used in the lecture notes. Some comments to the questionnaire indicate a certain irritation that the lectures were not following the lecture notes page by page. This could also explain the comment that the compendium was not easy to read (but it could also indicate the need for comments and details as normally expected in a book). The wish of a teacher to present the course material in a somewhat different order than the lecture notes would be simplified by using only an electronic version based on blocks of material which can be linked depending on the specific needs. This is an important aspect since the inspiration of teaching is very much related to present the material in a personal manner.
5 CONCLUSIONS

A web-based course developed in collaboration between teachers could help in the timeconsuming work to develop and update teaching material. A standard core of material with links to applications and various special material at other web-sites is a flexible concept also opening up for other types of collaborations. A web-based course can of course provide possibilities for new students to follow the course material but the question of examination is not easily solved. So far only some few comments have been obtained and then from Asian countries.

The risk of a web-based course is the same as of any printed material i.e. that it is not updated. At least the web-based course is more easily updated, errors can be quickly corrected, additional material included, new chapters added. But this will probably only happen if teachers find the material useful and are prepared to help in developing it. The stimulation to develop the lecture notes is coming through contacts with teachers and students.

Although the intention is to make the course material available free of charge it could be foreseen that there may be some costs associated with additional material such as software, application demonstrations and packages of exercises etc developed to make the course material more useful.

Teachers are invited to use the lecture notes and are welcome to help in changing and updating the course material. If interest is shown an editing group could be formed to take responsibility for yearly revisions. Teachers interested in the course material or in changes of the material are invited to contact the author, Jan.Askne@rss.chalmers.se.

ACKNOWLEDGEMENT

My PhD- and M.Sc.- students over the years are acknowledged for their inspiration and stimulation and for their contributions. In particular Dr G. Smith, responsible for the course today, and Prof. L. Ulander are gratefully acknowledged for their help and support now and earlier. The Swedish Space Agency has supported some of the course development.